SCANORA 3Dx
Cone Beam 3D Imaging System

Service Manual

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SCANORA 3Dx
Cone Beam 3D Dental Imaging System

Service Manual

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Manufactured by SOREDEX
Nahkelantie 160,Tuusula
FI-04301 Tuusula
Finland
Tel. +358 (0)10 270 2000
Fax. + 358 9 701 5261

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1. The CBCT unit service manual

1.1 Introduction

This manual describes how to troubleshoot and service the 3D cone beam computerized tomography x-ray unit (the CBCT unit).

1.2 The CBCT unit

The **CBCT unit** is a cone beam computerized tomography x-ray system intended to take digital images of the dentomaxillofacial complex.
It uses a CMOS flat panel detector to acquire 3D images and an optional CCD sensor to acquire panoramic images.
The device must only be used and operated by dentist and other qualified healthcare professionals.
The device must only be used for the purpose for which it is intended.

USA only
Caution: Federal law restricts this device to sale by or on the order of a dentist or other qualified healthcare professional.

1.3 Associated documentation

- The user's manual supplied with the CBCT unit.
- The installation and set -up manual supplied with the CBCT unit.
- The user's manual supplied with the SCANORA Workstation software.
- The user's manual supplied with the 3D viewing software.

1.4 Service precautions and warnings

Servicing precautions

Only personnel trained and approved by the manufacturer of the unit are allowed to service the unit.

Before attempting to service the device make sure that you know how to operate it. Read the user's manual.

Read and familiarize yourself with the warnings and precautions listed in the user's Manual.

Only use original spare parts from the manufacturer when repairing the device or replacing parts.

The unit is factory set to operate using a 230 - 240 ±10% VAC power supply. Never connect the unit to a power supply different to the voltage marked on the unit.

Warning - Radiation Safety

Before servicing the unit familiarize yourself with local and national radiation safety standards and requirements relating to x-ray equipment.

When taking test exposures take all adequate precautions to protect yourself from radiation. Stand behind a suitable radiation shield positioned at least two metres (six feet) from the unit.

Warning - Mechanical safety

Disconnect the unit from the main power supply before removing any covers.

Disconnect the unit from the main power supply before repairing or replacing mechanical parts or installing accessories.

Be careful when operating the unit not to get body parts or clothing trapped between moving parts.

During operation some surfaces and components may become hot. Take precautions to avoid burning yourself.

The aperture plate in the collimator is made of lead (Pb) which is toxic. Do not touch it with your bare hands.

Do not open the tubehead. There are no serviceable parts, mechanical or electrical, inside the tubehead.

Warning - Electrical Safety

Disconnect the unit from the main power supply before replacing circuit boards or other electrical components.

If there are capacitors on a circuit board or electrical device wait ten (10) minutes, after disconnecting the unit from the power supply, before handling the board or device.

If you have to leave the unit unattended with covers removed during servicing or maintenance, disconnect the unit from main power supply so that anyone who inadvertently touches the unit does not receive an electric shock.

This unit should only be used in areas that are provided with a protective earth connection to ensure an equipotential ground connection.

Caution - Electrostatic discharge

Electrostatic Discharge (ESD) can damage or destroy electronic components.

When servicing the device take precautions to avoid electrostatic build up and discharge (ESD). Follow the recommendations for the prevention of ESD that are used in the country in which you are working. If no recommendations are available follow the guide lines below.

Leave all new or replacement circuit boards and electrical parts in their protective packaging until the boards are needed.

Before handling circuit boards and electrical parts make sure that any static electricity charge that has built up in you body is discharged.

When handling circuit boards hold them by their edges and do not touch any connectors or components.

When examining and checking circuit boards use an elastic wrist wrap which is connected to a ground point through a 1 Mohm current limiting cable. For a ground point use water pipes, radiators or other objects that are known to be connected to the ground. Also use a cable to connect the unit to the same ground potential as the wrist wrap.

If an antistatic mat is used, connect the wrist wrap to the mat and the mat to the ground potential.

Wash the wrist wrap and check that it is in good condition frequently.

Warning - Explosion hazard

Some disinfectants and cleaning agents may vaporize to form an explosive vapour. If such disinfectants and cleaning agents are used the vapour should be allowed to disperse before switching the unit on.

Warning - Cleaning the unit

Switch the unit off and disconnect it from the main power supply before cleaning or disinfecting the unit. Refer also to the User's manual for additional information.

1.5 Unauthorized Modifications

Unauthorized changes or modifications to any part of the unit or its equipment can have hazardous consequences. Changes or modifications must not be made unless specifically authorized by the manufacturer.

When properly assembled with a compatible beam-limiting device, the diagnostic source assembly will fully meet the United States of America Federal Performance Standards for Diagnostic X-Ray Systems and Their Components (21 CFR 1020. 30-32) provided no components or parts are removed from the unit and no unauthorized adjustments are made to the beam-limiting device or tube housing assembly.

Never remove or remanufacture any part of the tube-head assembly or beam-limiting device.
Never adjust any part of the beam-limiting device unless under the direction of the manufacturer or their authorized distributor.

1.6 Disclaimer

The manufacturer shall have no liability for consequential damages, personal injury, loss, damage or expense directly or indirectly arising from the use of its products. No agent, distributor or other party is authorized to make any warranty or other liability on behalf of the manufacturer with respect to its products.

1.7 Disposal

At the end of useful service life of the device, its spare parts, its replacement parts and its accessories make sure that you follow all local, national and international regulations regarding the correct and safe disposal and/or recycling of the device, its spare parts, its replacement parts and its accessories.

The device, its spare parts, its replacement parts and its accessories may include parts that are made of or include materials that are non-environmentally friendly or hazardous. These parts must be disposed of in accordance with all local, national and international regulations regarding the disposal of non-environmentally friendly or hazardous materials.

Hazardous materials and parts that are made of or contain these materials:

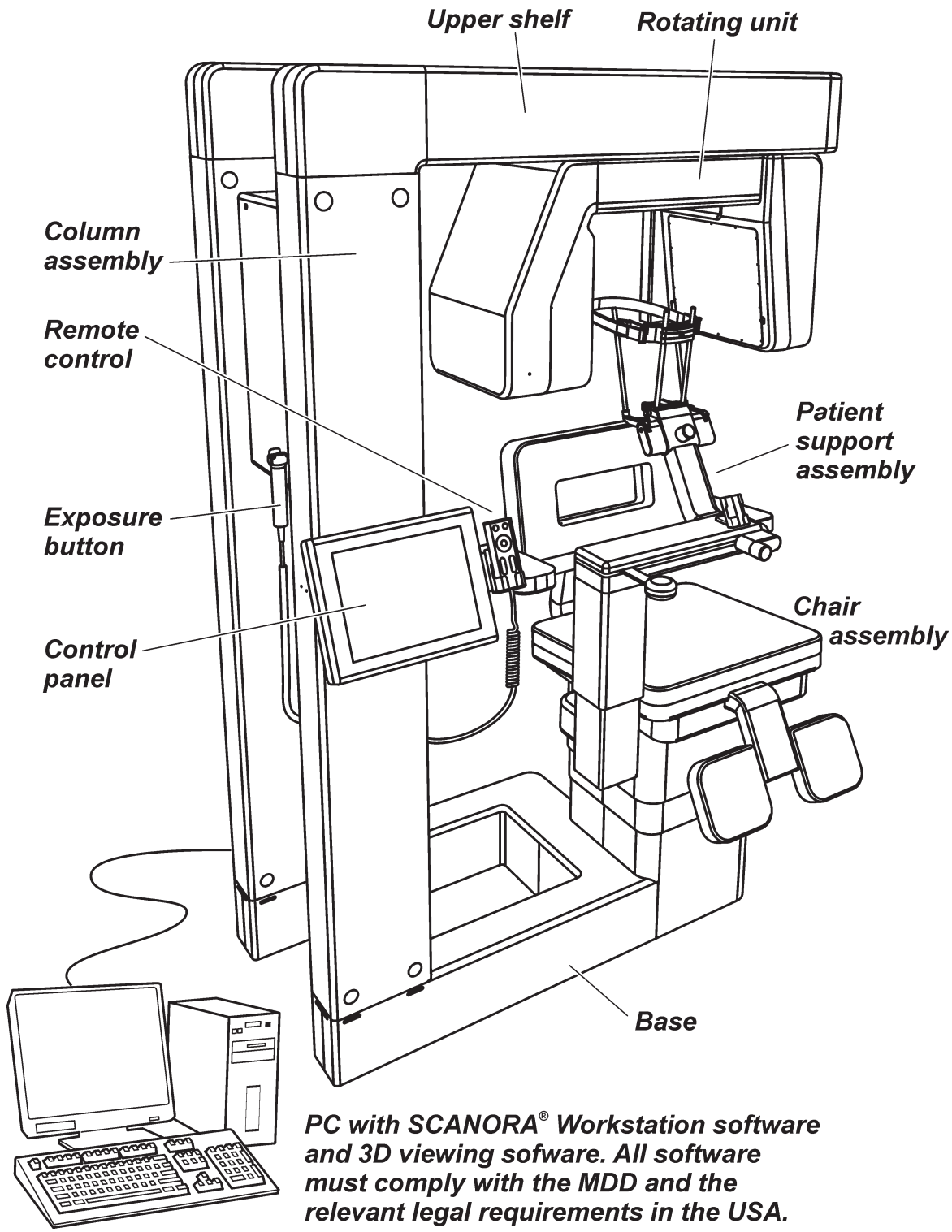
- **Lead**
  Tubehead housing, collimator, circuit boards

- **Tubehead oil**
  Inside tubehead.

- **Amorphous Silicon (a-Si)**
  3D sensor, CCD sensor.

2. Mechanical description

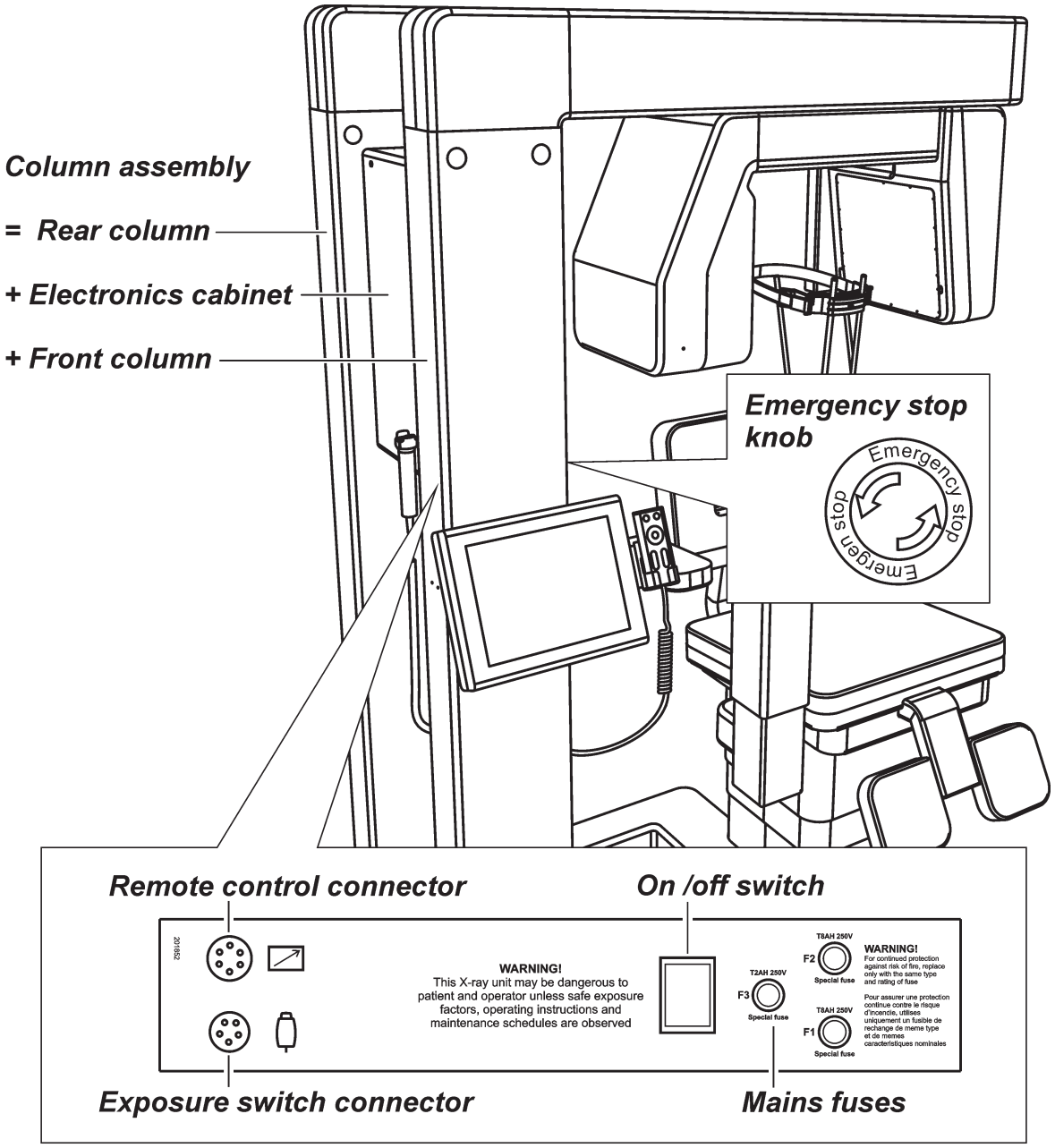
2.1 Main parts and assemblies



PC with SCANORA® Workstation software and 3D viewing sofware. All software must comply with the MDD and the relevant legal requirements in the USA.

The Unit comprised a **base** on which is mounted a **chair assembly** and a **column assembly**.
Attached to the top of the column assembly there is the **upper shelf**.
Attached to the underside of the upper shelf is the **rotating unit**.
Fixed to the side of the chair assembly there is the **patient support assembly**, which supports the patient's head when the patient is seated in the chair.
The **control panel**, for operating the unit, is attached to the front of the column assembly (refer to the user's manual for a description of the control panel).
A holder attached to the side of the control panel holds the **remote control**. This is used to position the patient (refer to the user's manual for a description of the remote control).
The **exposure button** is attached to the side of the column.
A **PC** with MDD compliant dental imaging software and 3D viewing software is connected to the unit via an Ethernet cable.

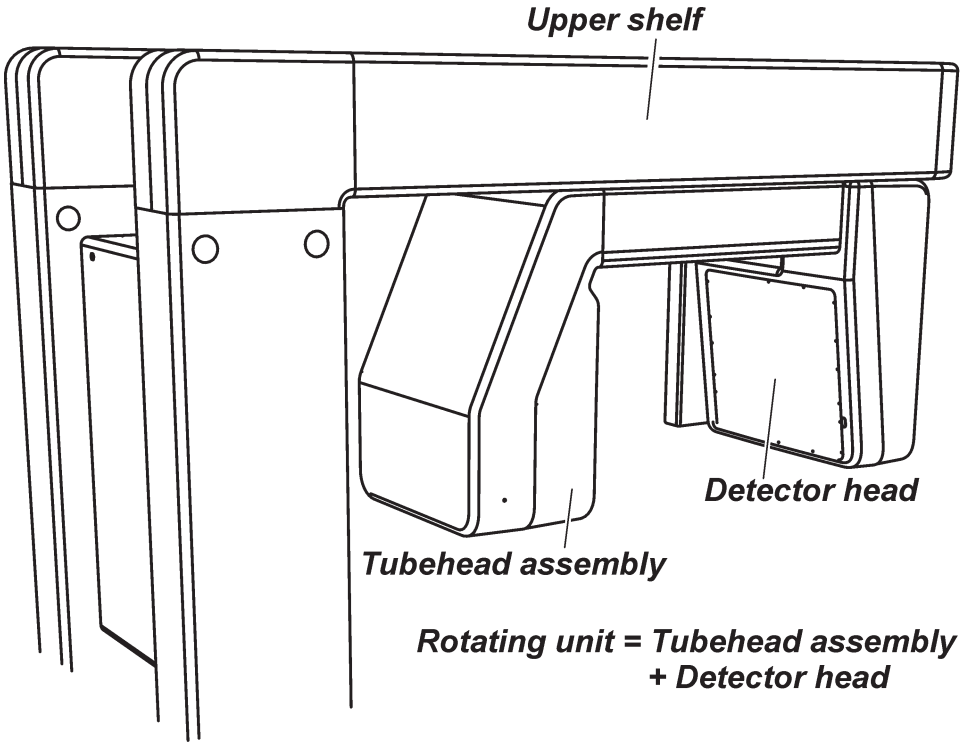
2.2 The column assembly

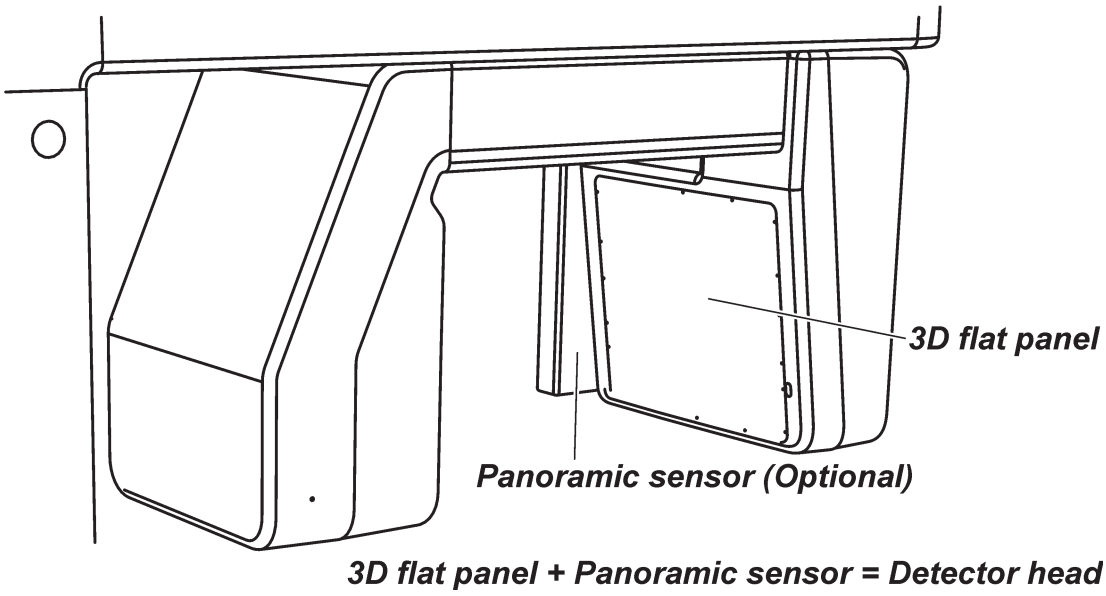

Column assembly
= Rear column
+ Electronics cabinet
+ Front column
Emergency stop knob
Emergency stop
Remote control connector
On /off switch
WARNING!
This X-ray unit may be dangerous to patient and operator unless safe exposure factors, operating instructions and maintenance schedules are observed
T8AH 250V
F2
Special fuse
WARNING!
For continued protection against risk of fire, replace only with the same type and rating of fuse
T2AH 250V
F3
Special fuse
T8AH 250V
F1
Special fuse
Pour assurer une protection continue contre le risque d'incendie, utilisez uniquement un fusible de rechange de meme type et de memes caracteristiques nominales
Exposure switch connector
Mains fuses

Underside of electronics cabinet

The **column assembly** comprises a **front column** and a **rear column**. An **emergency stop knob** is located on the “chair side” of the front column. Between the front and rear columns is the **electronics cabinet** which houses the HD and circuit boards are located. The **on/off switch** for the unit, the **main fuses** and the **exposure switch** and **remote control connectors** are located on the underside of the electronics cabinet.

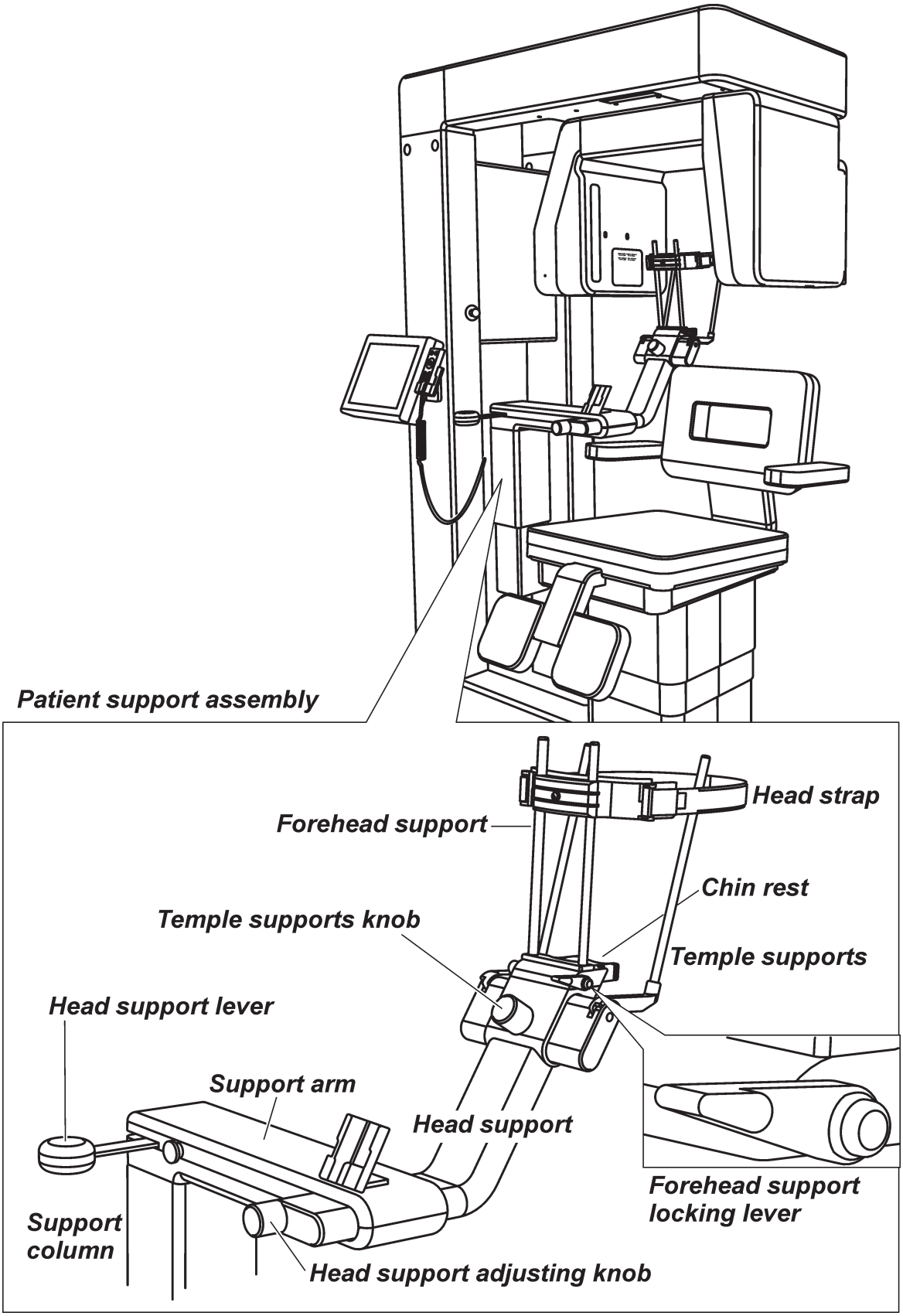
2.3 The rotating unit





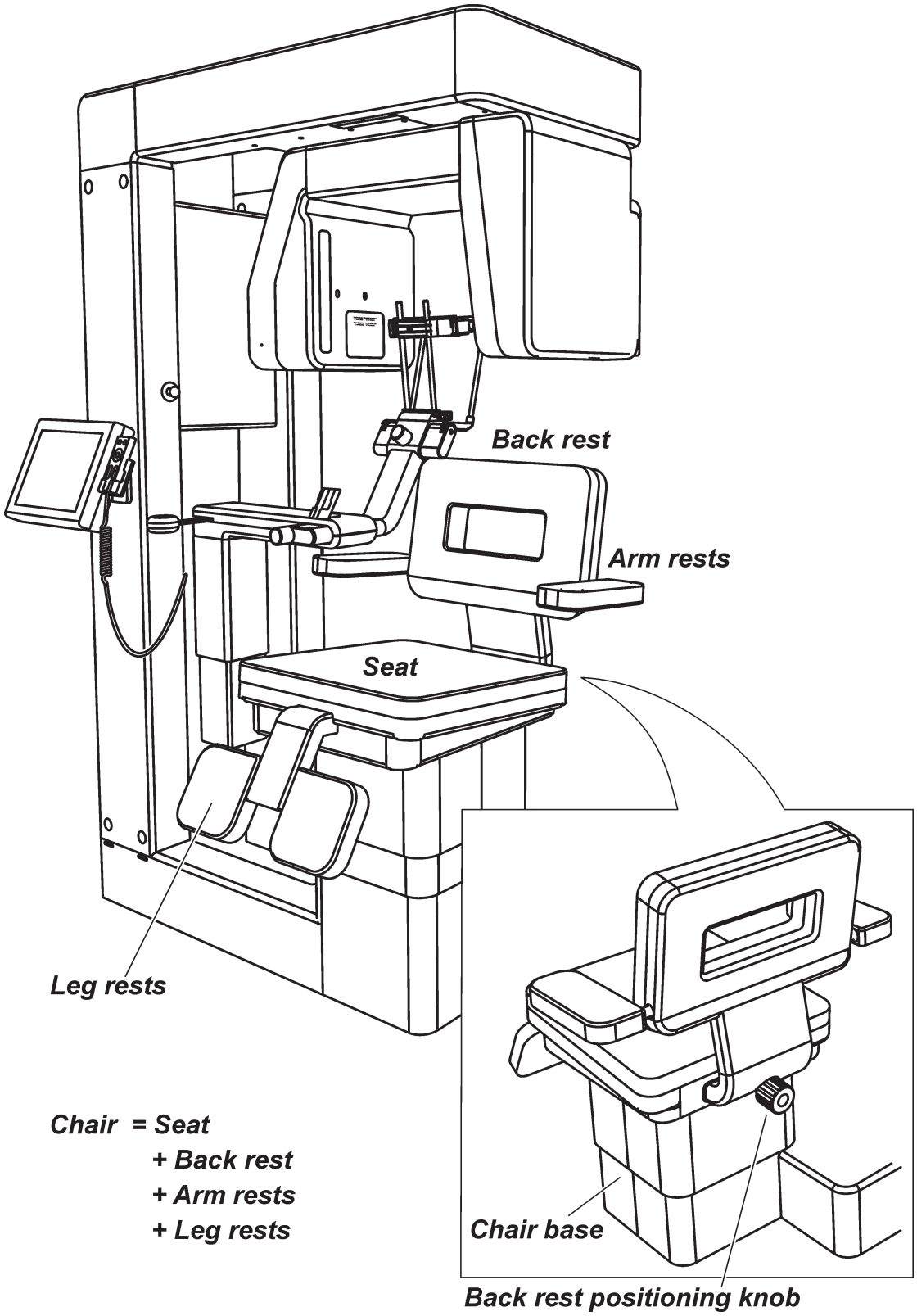
The **rotating unit** is attached to the **upper shelf**. The rotating unit comprises the **tubehead assembly** and the **detector head**. In the top of the rotating unit there is a stepper motor which rotates the rotating unit during the imaging procedure.
A motor in the upper shelf moves the rotating unit to the left or right to position it for the required imaging program.
The detector head comprises the **3D flat panel** and, if the unit is a 3D pan version, the **pan sensor** will be attached to the side of the 3D detector.
When the pan program is selected, the pan sensor automatically rotates forward to the correct position.
There are six positioning light in the rotating unit, four for 3D images and (OPTIONAL) two for panoramic.
There is one patient position light in the upper shelf that is used for both 3D and panoramic images.

2.4 The patient support assembly



The **patient support assembly** is attached to the side of the chair assembly. The patient support assembly comprises a **support column** which can be driven up and down to position the angle of the patient head. Mounted on top of the support column is the **support arm** which can be rotated away from the unit to allow patient entry and exit. The support arm is locked in position with the **head support lever**.
Attached to the support arm is the **head support** that can be manually adjusted backwards and forwards with the **head support adjusting knob**.
At the top of the head support there is the **chin rest**. Various patient positioning accessories can be attached to the chin rest to support the patient's head.
On both sides of the chinrest there are **temple supports** that can be manually closed, to support the patients head, with the **temple supports knob**.

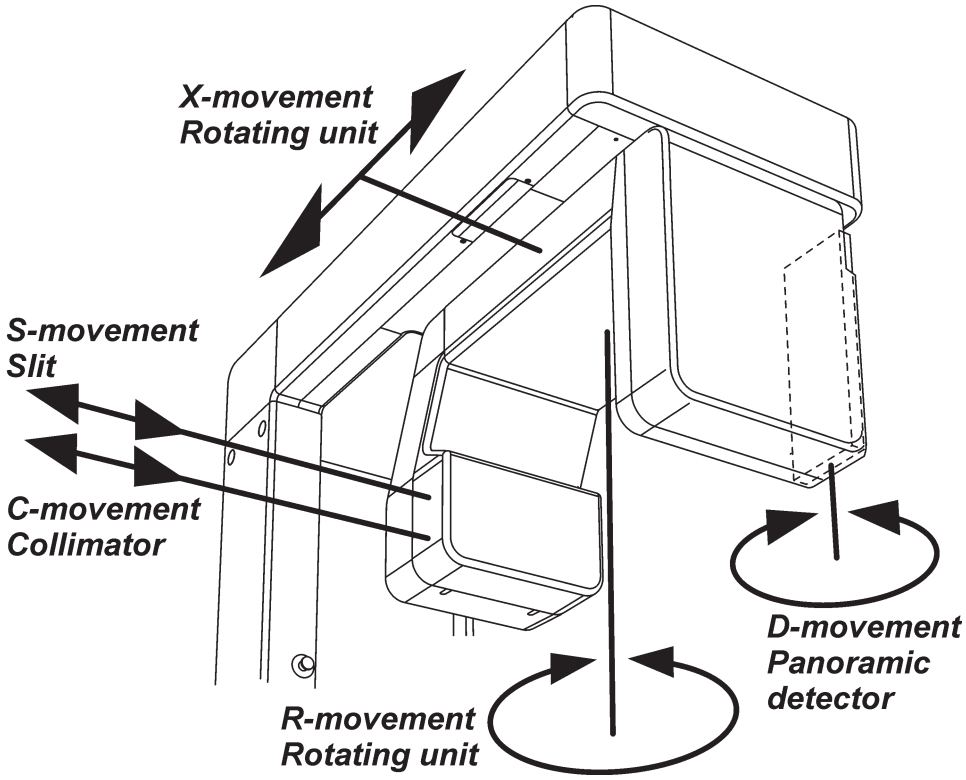
2.5 The chair assembly



Chair = Seat
+ Back rest
+ Arm rests
+ Leg rests

The **chair assembly** comprises the **chair base** and the **chair**. A motor in the chair base adjusts the height of the chair so that the patient can be positioned in the vertical direction.
The chair comprised the **seat**, the **back rest**, the **arm rests**, which can be lifted up to allow patient entry and exit, and the **leg rests**.
A motor in the seat allows the patient to be positioned in the backwards forwards direction.
The **back rest positioning knob** at the rear of the chair allows the position of the backrest to be adjusted for different size patients.
The seat and backrest upholstery are attached to the chair assembly using hook-loop (Velcro) tape.
An optional seat cushion is available to position children at the correct height.

2.6 Unit movements and motors



C-movement (Collimator)

Collimator.
Adjusts the height (top edge) of the collimator slit.
Used for the different imaging programs.
Motor: Stepper, inside the tubehead assembly.

D-movement (Panoramic detector) (Optional)

Rotates the panoramic detector into the panoramic exposure position.
Motor: Stepper, inside the detector head.

R-movement (Rotating unit)

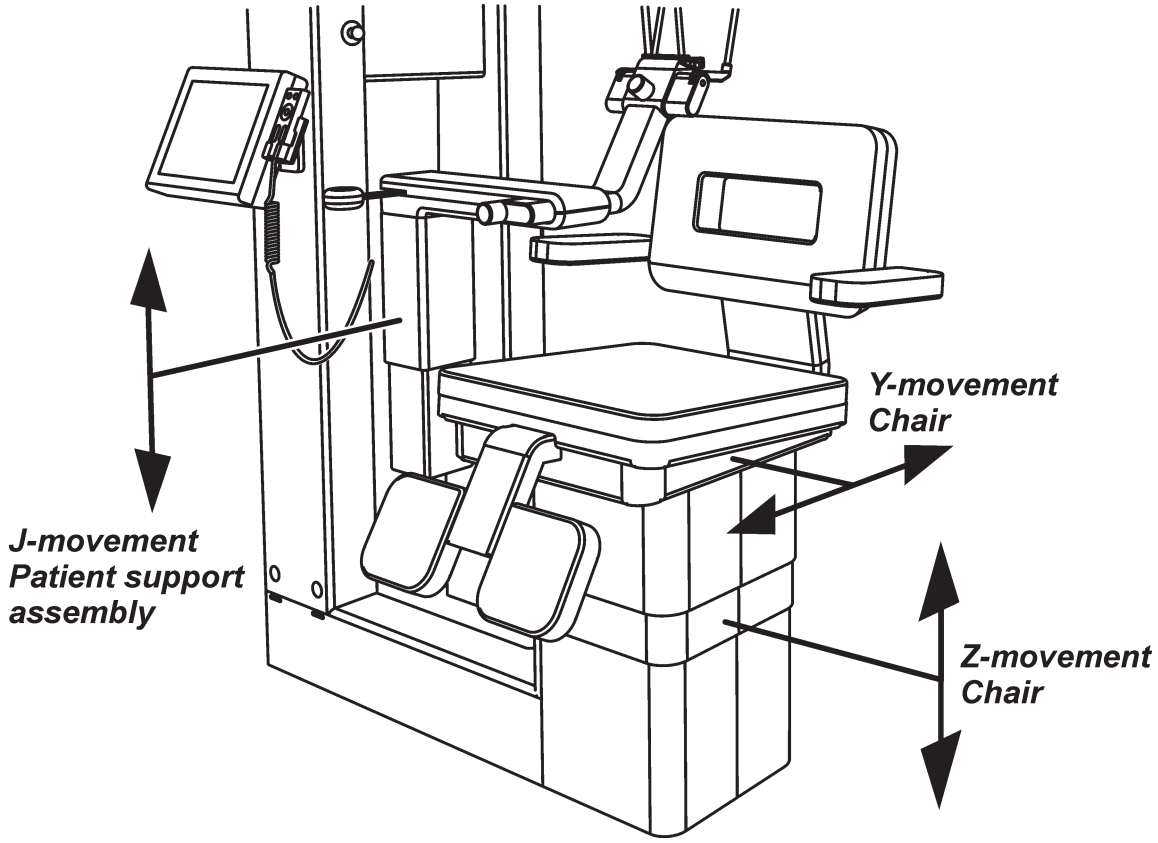
Rotating unit.
Rotating movement of the rotating unit.
Used to take exposures.
Motor: stepper, in the top of the rotating unit.

S-movement (Slit)

Collimator.
Adjusts the width (left and right edges) of the collimator slit.
Used for the different imaging programs
Motor: Stepper, inside the tubehead assembly.

X-movement (Rotating unit)

Rotating unit.
Left / right movement of the rotating unit. Used to move the rotating unit during patient positioning
Motor: Stepper, under in the top shelf.



J-movement (Patient support assembly)

Patient support assembly.
Up / down movement of the patient support assembly.
Used to adjust the angle of the patient's head.
Motor: DC, in the chinrest support.

Y-movement (Chair)

Chair.
Backwards / forwards movement of the patient chair.
Used to position the patient in the backwards/forwards direction.
Motor: Stepper, under the seat.

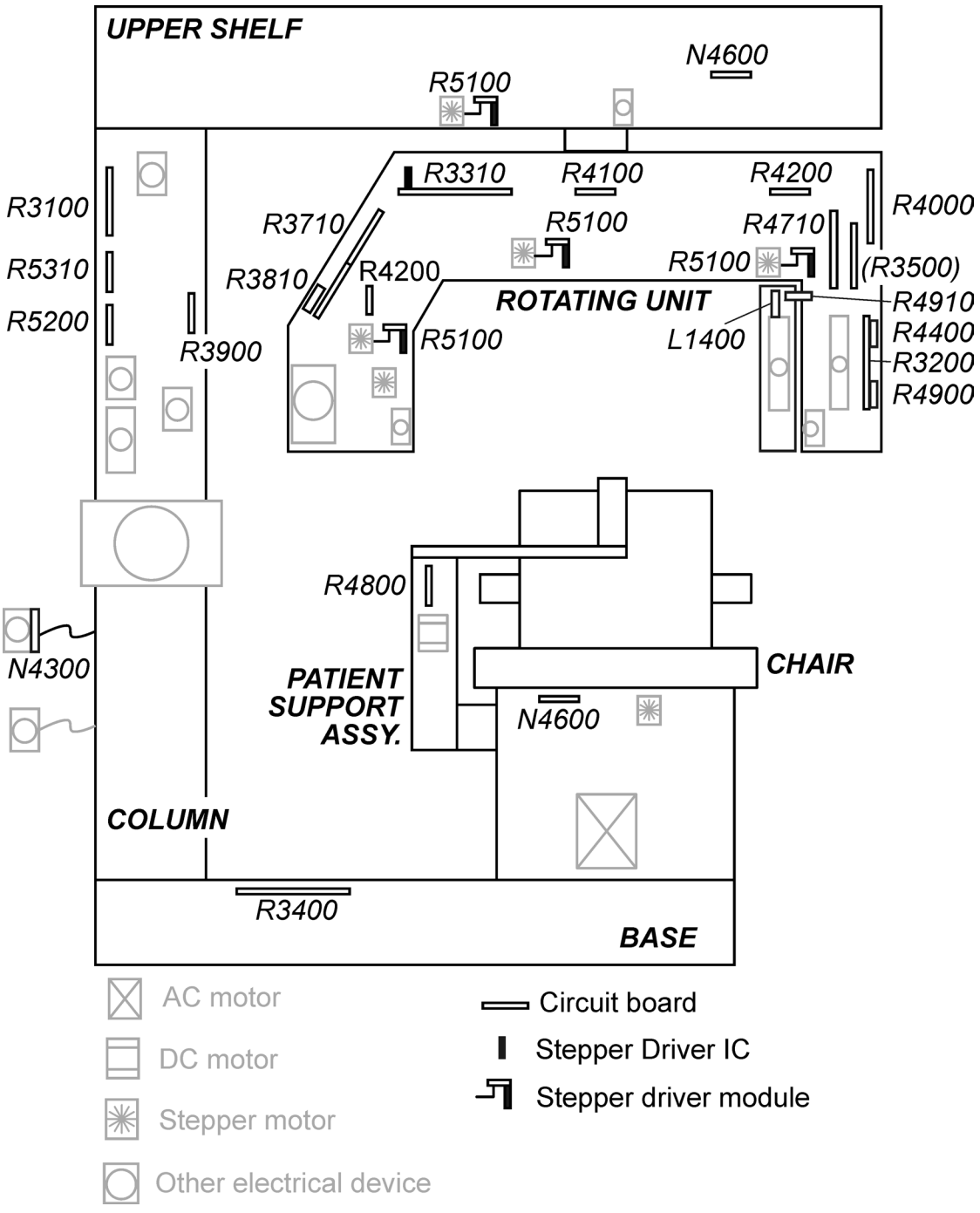
Z-movement (Chair)

Chair.
Up / down movement of the chair.
Used to position the patient vertically.
Motor: AC in the chair base.

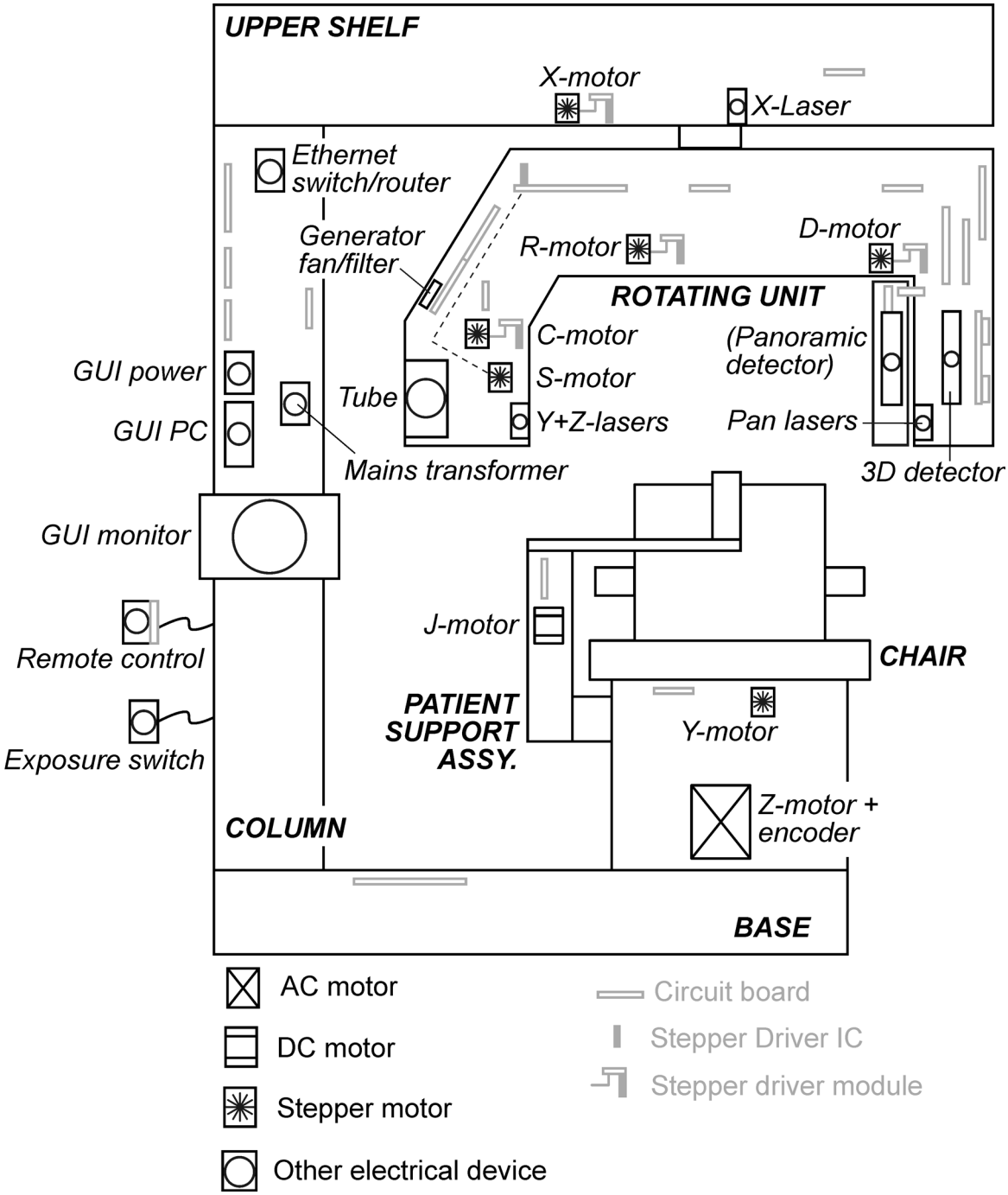
3. Electrical description

3.1 Electric component location

Circuit boards



Other electric devices



3.2 List of circuit boards and electric devices

- R3100 Power supply
  Location - electronics cabinet.
  Type - power supply, low power.

- R3200 CPU
  Location - rotating unit (detector head).
  Type - logic. Includes an FPGA integrated circuit and embedded SW.

- R3310 IO1
  Location - rotating unit (top part).
  Type - logic. Includes an FPGA integrated circuit and embedded SW.

- R3400 IO2
  Location - base.
  Type - logic. Includes an FPGA integrated circuit and embedded SW.

- R3500 CCD power supply
  Location - rotating unit (detector head).
  Type - power supply, low power.

- R3710 X-ray power supply
  Location - rotating unit (tubehead assembly).
  Type - power supply, **high power**.

- R3810 X-ray generator
  Location - rotating unit (tubehead assembly).
  Type - power supply, **high power**.

- R3900 Mains connector
  Location - electronics cabinet.
  Type - satellite connector board.

- R4000 Connector
  Location - rotating unit (detector head).
  Type - satellite connector board.

- R4100 Rotator opto
  Location - rotating unit (top part).
  Type - satellite board.

- 2 x R4200 Opto sensor
  Location - rotating unit (tubehead assembly).
  Location - rotating unit (detector head).
  Type - satellite board.

- R4300 Remote control
  Location - front column, it is connected to the electronics cabinet.
  Type - satellite board.

- R4400 Panel data adaptor
  Location - rotating unit (detector head).
  Type - satellite board.

- 2 x N4600 Opto sensor
  Location - upper shelf.
  Location - chair.
  Type - satellite board.

- R4710 3D panel power supply
  Location - rotating unit (detector head).
  Type - power supply, low power.

- R4800 Chin rest opto
  Location - patient support assembly.
  Type - satellite board.

- 2 x R4910 Panorama interface
  Location - rotating unit (detector head).
  Type - satellite connector board.

- 4 x R5100 3-phase stepper driver
  Location - rotating unit (top part).
  Location - upper shelf.
  Location - rotating unit (tubehead assembly).
  Location - rotating unit (detector head).
  Type - satellite board.

- R5200 ESD Protection
  Location - electronics cabinet.
  Type - Satellite connection board.

- R5310 Panel raw power supply
  Location - electronics cabinet.
  Type - power supply, low power.

- 3D-detector
  Location - rotating unit (detector head).

- C-motor (Collimator)
  Location - rotating unit (tubehead assembly).

- CCD-filter board and EMC-filter board.
  Location - rotating unit (detector head).

- Detector swapping motor
  Location - rotating unit (detector head).

- D-motor (Panoramic detector)
  Location - rotating unit (detector head).

- **Emergency stop button**
  Location - front column.

- Ethernet switch/router
  Location - electronics cabinet.

- Exposure switch
  Location - front column (it is connected to the electronics cabinet).

- Generator fan/filter
  Location - rotating unit (tubehead assembly).

- GUI PC
  Third-party GUI PC board. It communicates via the internal Ethernet.
  Location - electronics cabinet.

- GUI PC Power Supply
  Location - electronics cabinet.

- GUI touch panel monitor
  Location - front column.

- J-motor (Chin rest - DC)
  Location - patient support assembly.

- L1400 CCD-Filter board
  Location - rotating unit (detector head)

- Mains filter
  Location - base.

- Mains transformer
  Location - electronics cabinet.

- Panoramic detector (CCD) (optional)
  Location - rotating unit (detector head).

- Panoramic focal trough laser
  Location - rotating unit (detector head).

- Panoramic Z-laser
  Location - rotating unit (detector head).

- Positioning lasers, FOV-bottom, FOV-top (two, three or four depending on model), FOV-center (sagittal plane).
  Location - rotating unit.

- R-motor (Rotation)
  Location - rotating unit (top part).

- S-motor (Slit)
  Location - rotating unit (tubehead assembly).

- Warning light connector
  Location - base.

- X-motor (3-phase stepper)
  Location - upper shelf.

- X-positioning (coronal plane)
  Location - upper shelf.

- X-ray tube
  Location - rotating unit (tubehead assembly).

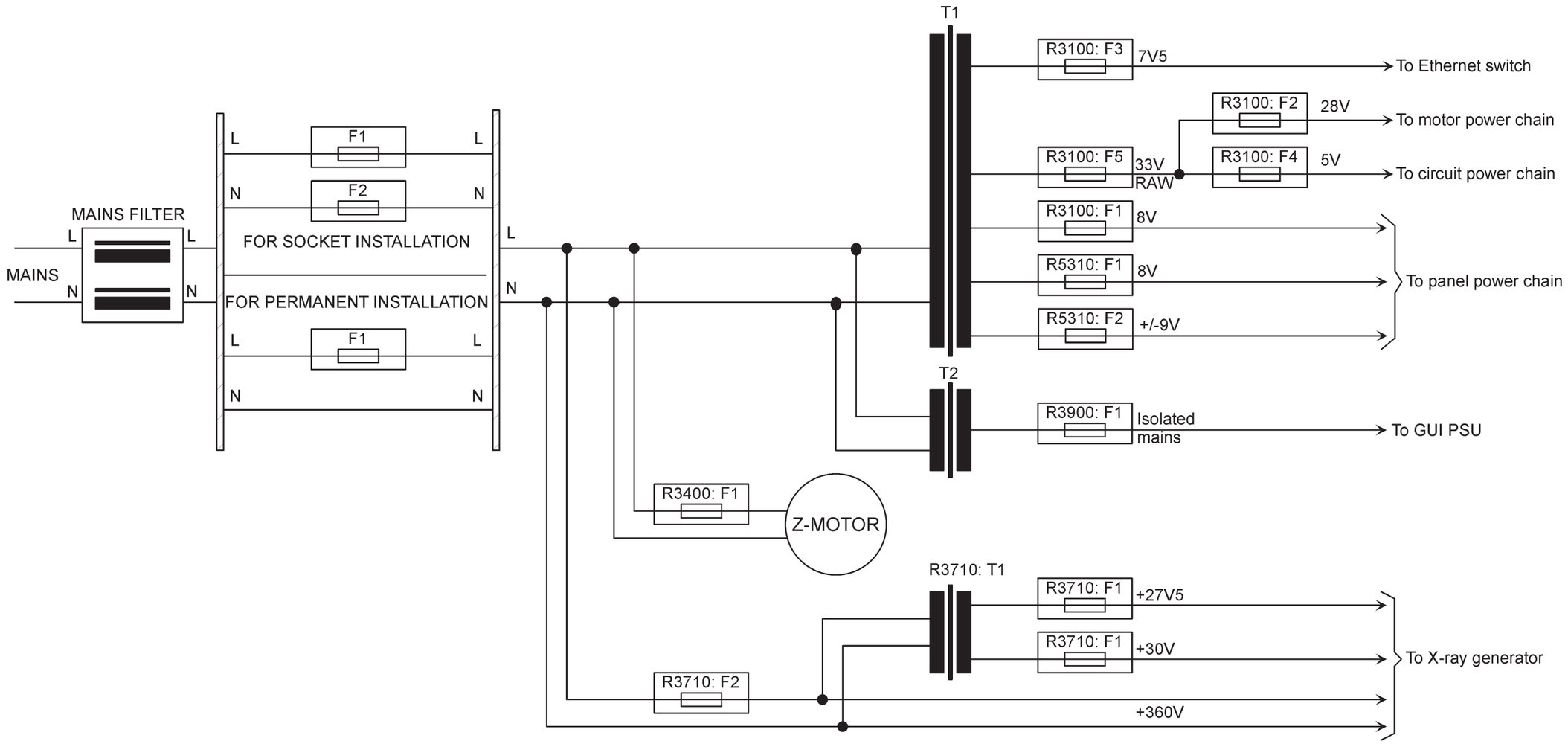
- Y-motor (3-phase stepper)
  Location - chair

- Z-movement encoder (single phase)
  Location - chair

- Z-movement motor (AC)
  Location - chair

3.3 Schematic diagrams

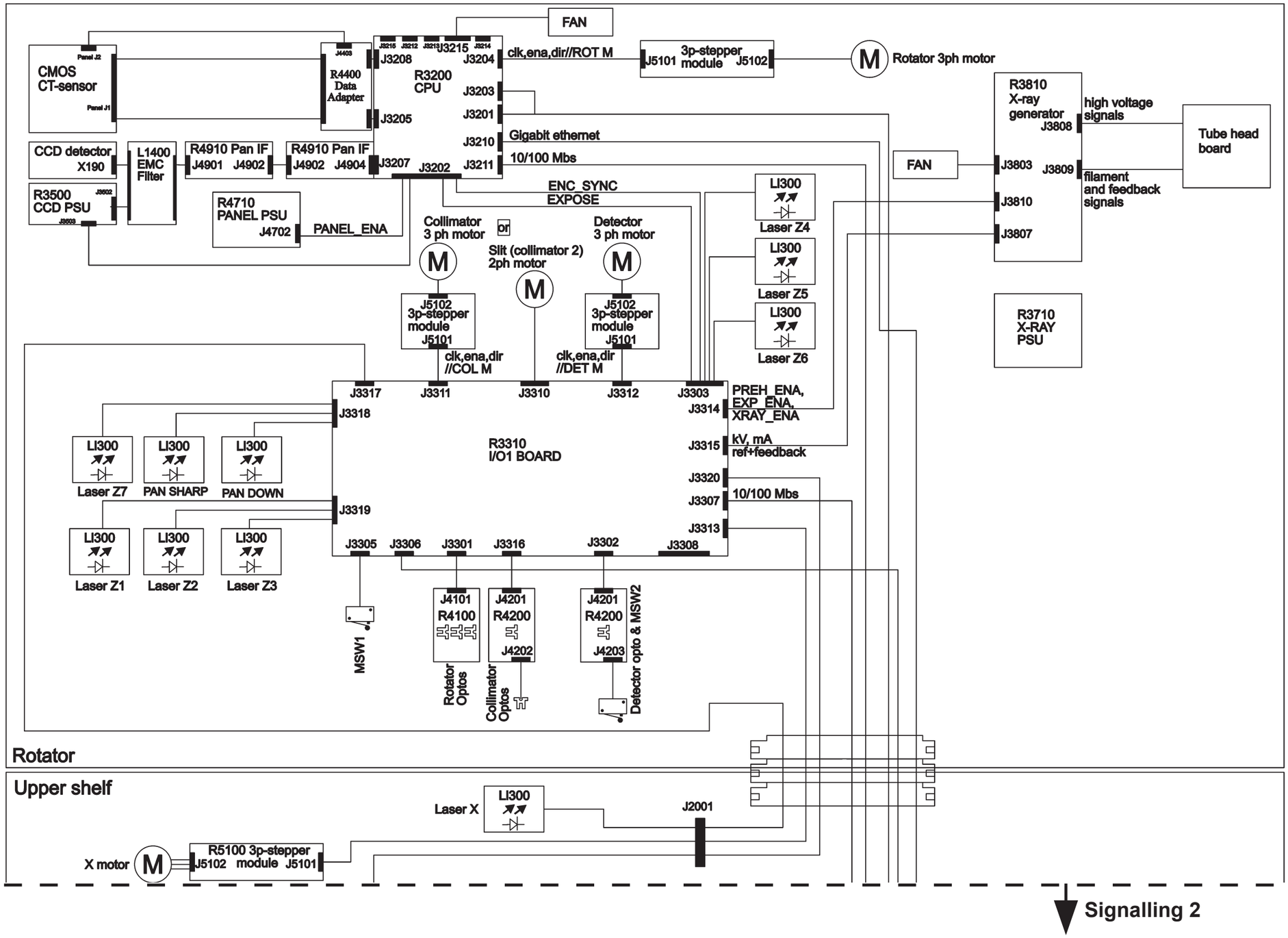
Fuse guide



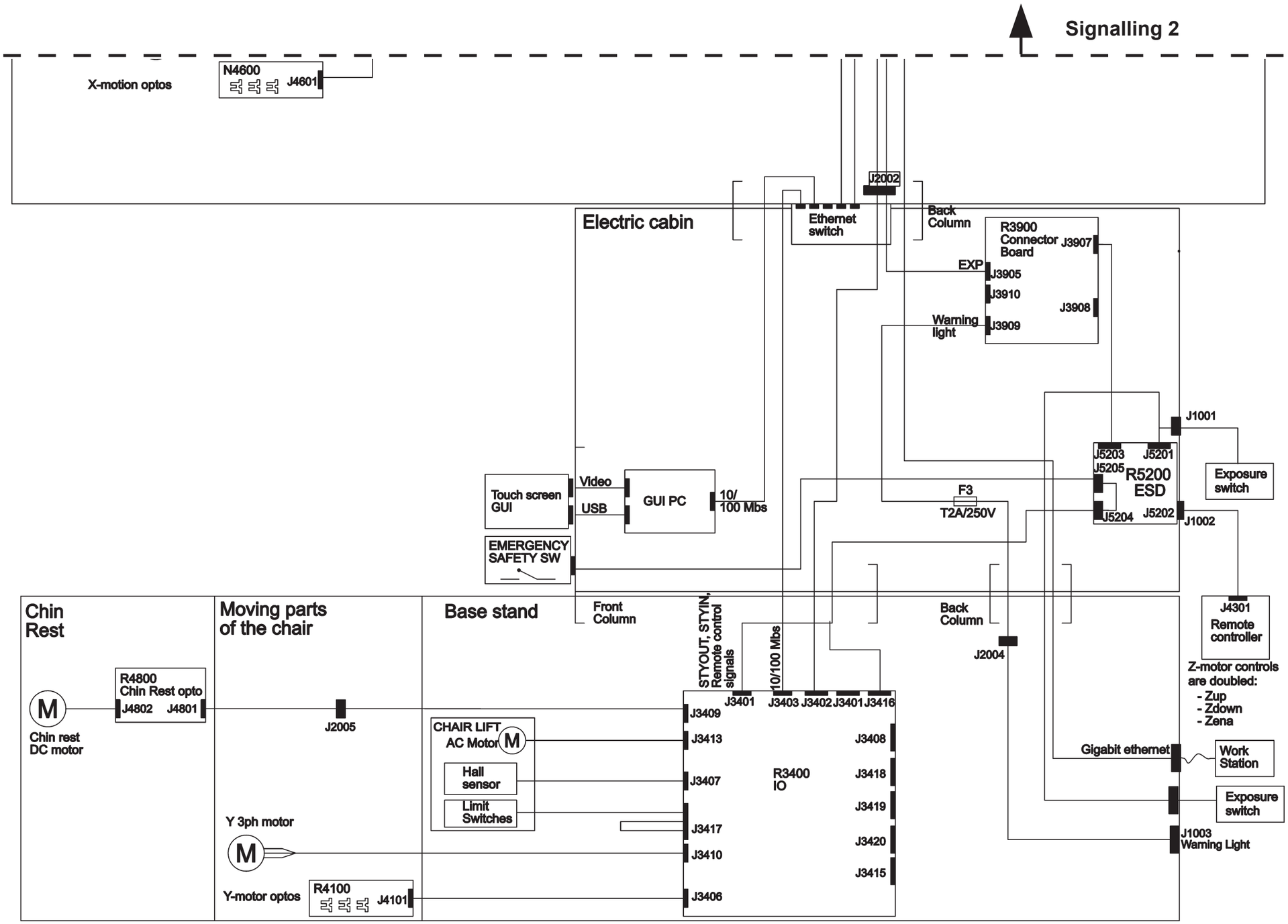
Notes:

- Fuse reference designators without board ID (Rxxxx:) are assambled to the frame of the SBR3D-2
- Actual values for fuses are specified in separate fuse list
- Mains fuse F2 is only used in NON-permanent installation.

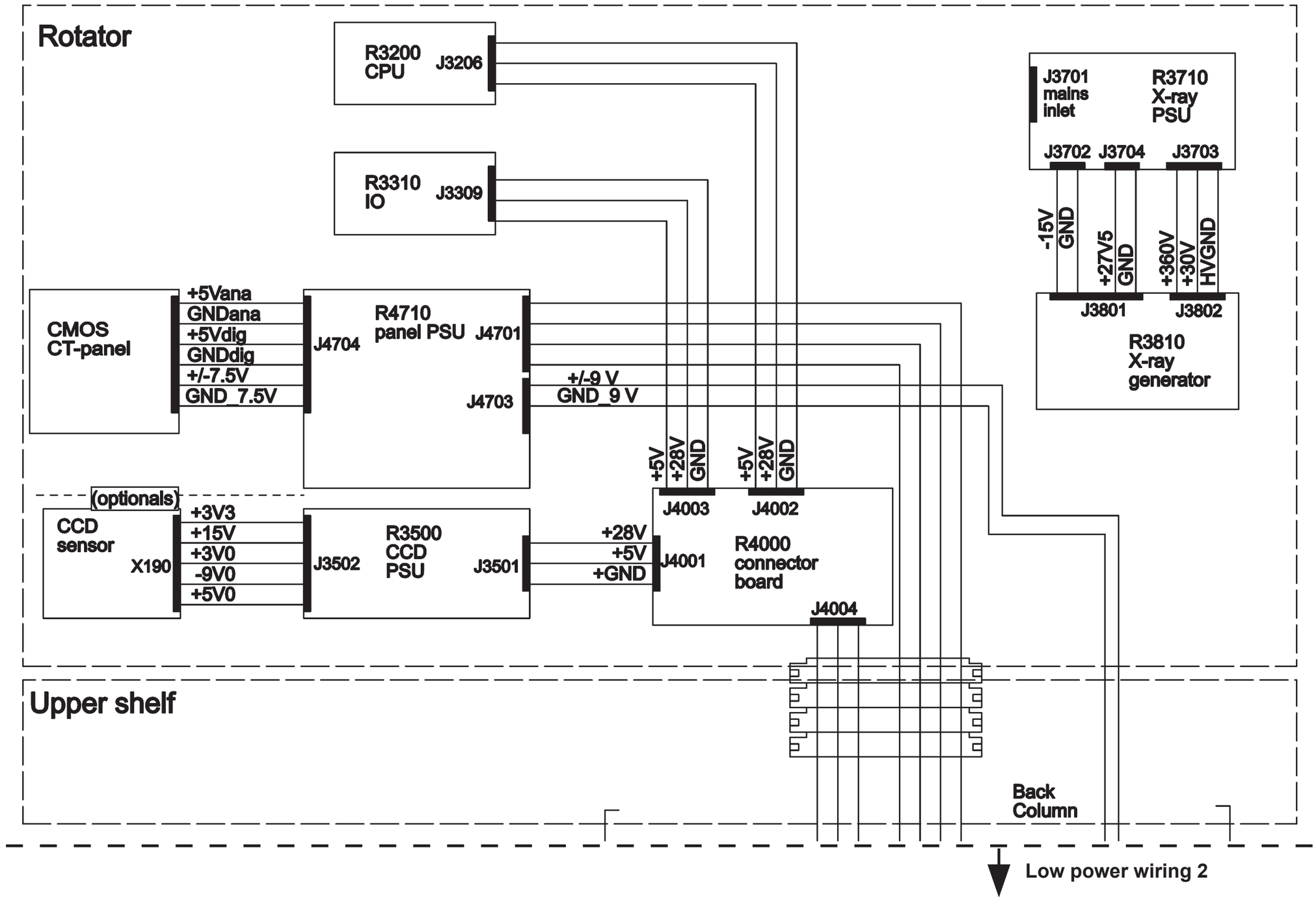
Signalling 1



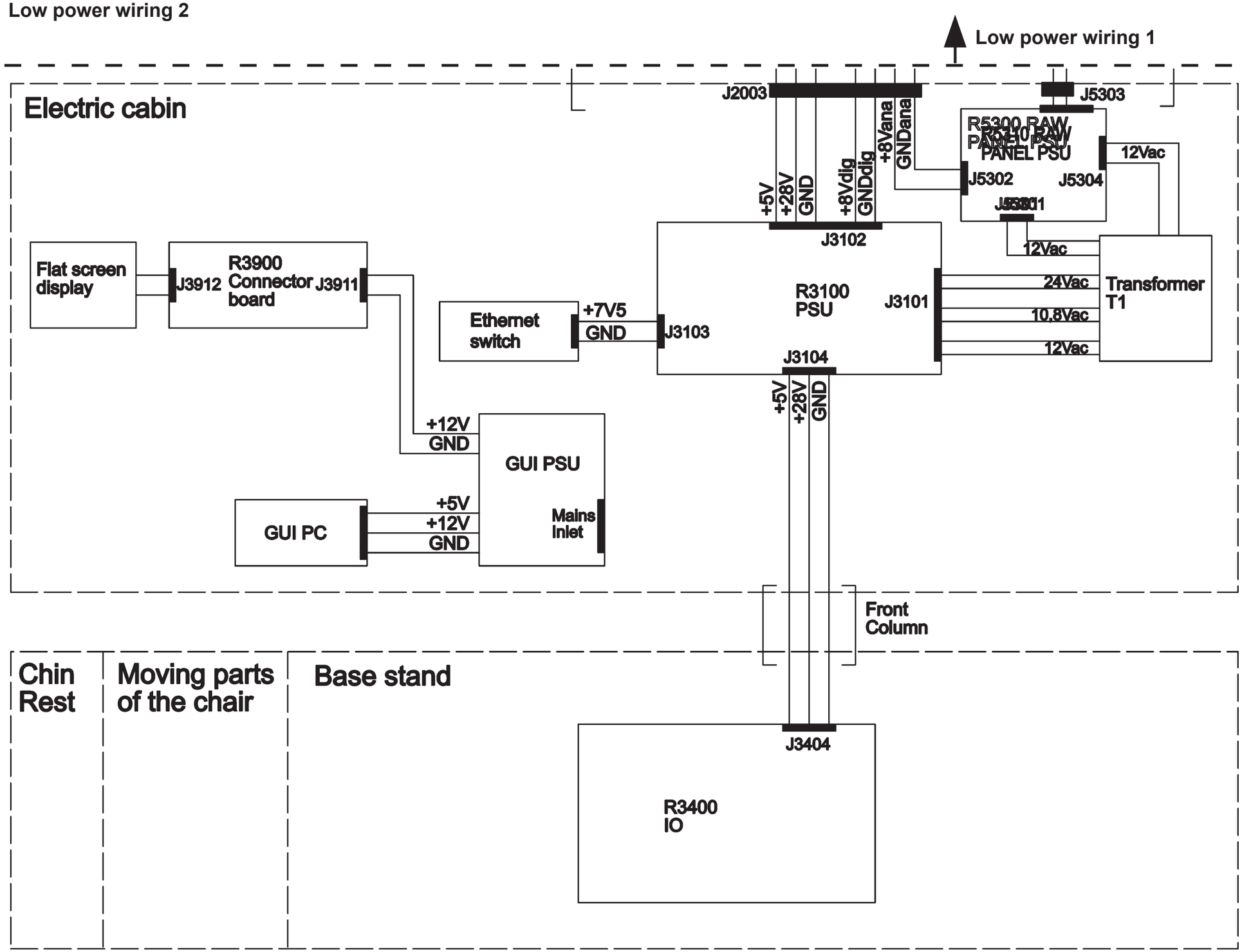
Signalling 2



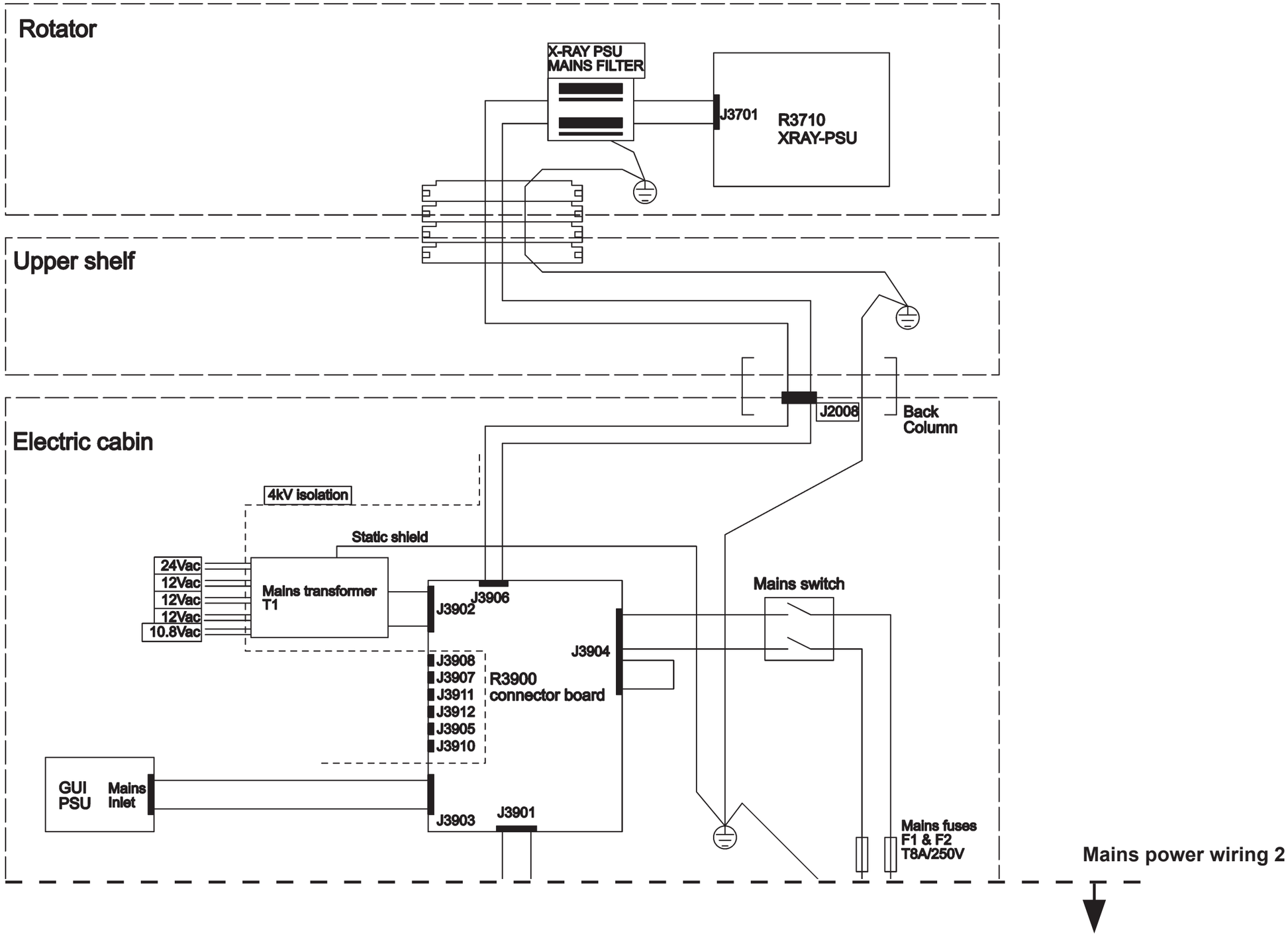
Low power wiring 1



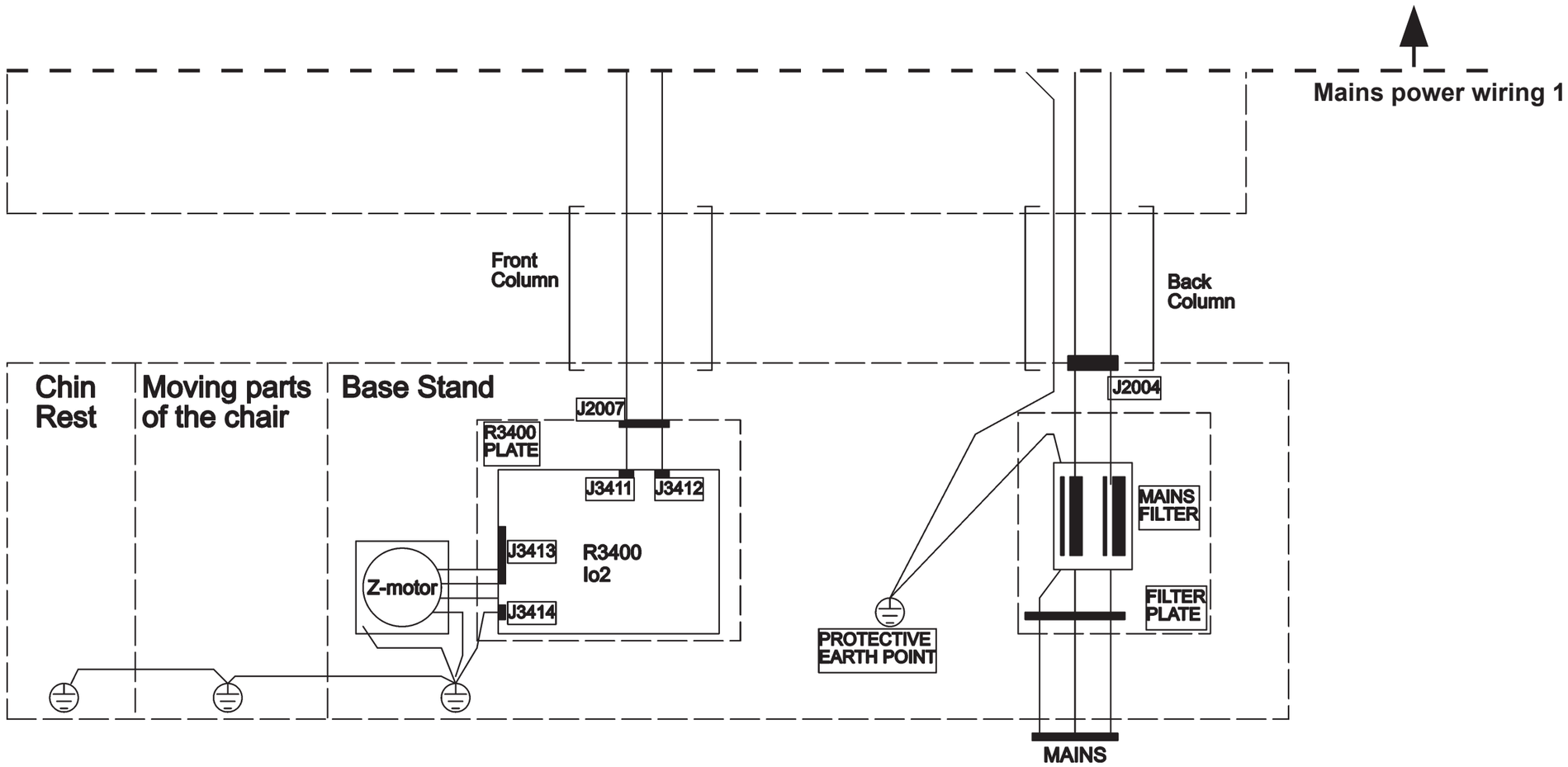
Low power wiring 2



Mains power wiring 1



Mains power wiring 2



3.4 Circuit board descriptions

R3100 Power supply

R3100 DESCRIPTION:
The main function is to generate the voltages needed for internal operation of the unit. It also has also a shutdown feature that can switch the +28V off as well as control the mains relay located in the electronics cabinet.

The input voltage comes from the mains transformer. Input AC voltages are rectified and regulated by a linear regulator or a switcher regulator.

R3100 LOCATION:
In the electronics cabinet.

R3100 INPUTS:
24Vac, mainly for motors
10.8Vac, for Ethernet switch
10.8Vac, for logic and for 3D-panel digital power

R3100 OUTPUTS:
+28Vdc for the stepper, DC motors and the CCD power supply.
+8Vdc for 3D sensor power supply
+7.5Vdc for the Ethernet switch
+5Vdc for the logic boards

R3100 FUSES:

ID	Value	Input voltage, LED	Output voltage, LED	Test pins	Fuse type
F1	F1A 250V	DIG_DC_IN, D21	+8V_DIG, D27	TP109-TP106	Littelfuse 313001 or 326001
F2	F3A 250V	D23	28V, D28	TP113-TP106	Littelfuse 312003 or 314003
F3	T2A 250V	ENET_DC_IN, D22	+7V5, D26	TP108-TP106	Littelfuse 313002 or 326002
F4	T6.3A 250V	-	+5V, D25	TP111-TP106	Littelfuse 313006.3P or 326006.3P
F5	T5A 250V	+28V_RAW, D20	+33RAW, D23	-	Littelfuse 313005(P) or 326005

All fuses are UL approved.
When replacing fuses ALWAYS use the same type, rating and size.

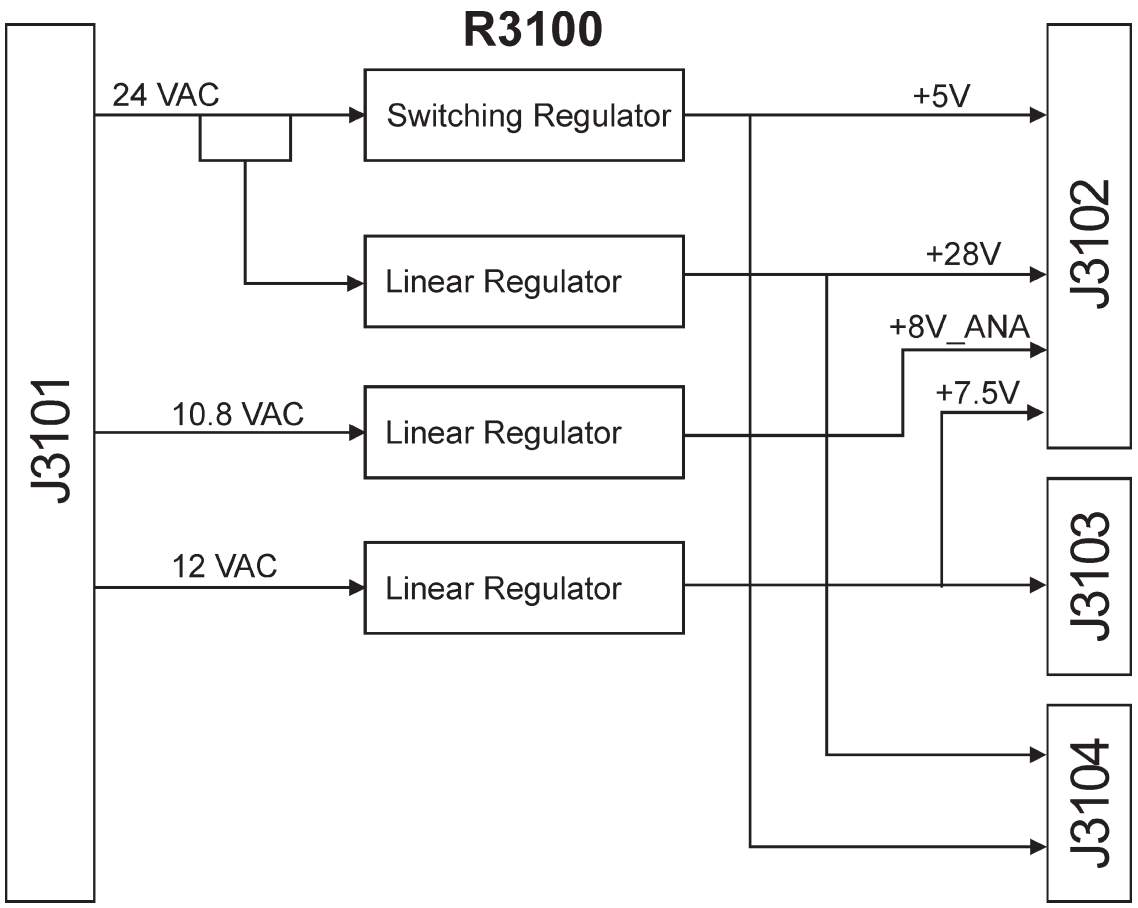
R3100 INDICATOR LEDS:

D20	+24Vdc_raw.	Raw voltage for motors and logic boards. On = Voltage OK.
D21	+10.8Vdc_dig.	Raw voltage for panel power supply. On = Voltage OK.
D22	+12Vdc_esw.	Raw voltage for Ethernet switch. On = Voltage OK.
D23	+33V	Input voltage for motors, On=Voltage OK
D25	+5Vdc	Output voltage for logic boards. On = Voltage OK.
D26	+7.5Vdc.	Output voltage for Ethernet switch. On = Voltage OK.
D27	+8Vdc_dig.	Output voltage for panel power supply. On = Voltage OK.
D28	+28Vdc.	Output voltage for motors. On = Voltage OK.

R3100 TEST PINS:

TP106	GND_DIG.
TP 108	+7.5Vdc.
TP109	+8Vdc_dig.
TP110	GND.
TP111	+5Vdc.
TP113	+28Vdc.

R3100 BLOCK DIAGRAM



R3200 CPU (Central Processing Unit)

R3200 DESCRIPTION:
Controls the main functions of the unit. Monitors and control the status of Detector Power Supply.
Includes an FPGA integrated circuit and embedded SW.

R3200 LOCATION:
In the detector side of the rotating unit.

R3200 CONTROL FUNCTIONS:
System control.
1Gb Ethernet for external communications.
100Mb Ethernet for internal communications.
3D-image grabbing.
Panorama image grabbing.
Image buffering in the DDRAM memory.
Rotation control signalling.
Y-motion control signalling.
Slit motor control signalling.

R3200 FUSES:
None

R3200 INDICATOR LEDS:

R3200 REL 6 and above

Giga Ethernet status LEDs:

D1	Duplex mode
D2	1GB
D3	100MB
D4	10MB
D5	Link activity

100M Ethernet status LEDs:

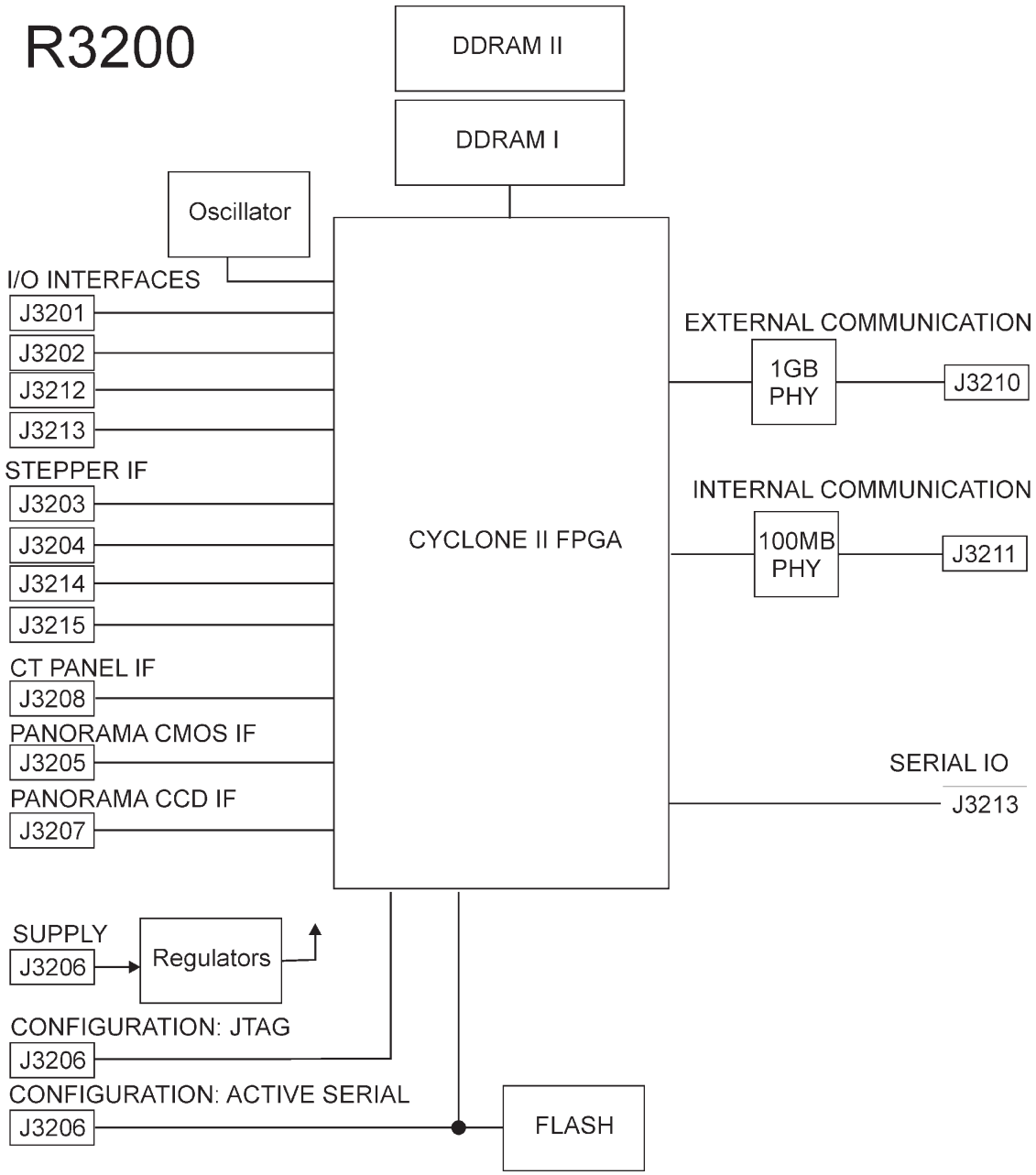
D6	100MB
D7	Link activity
D8	Link OK

Motor power status LEDs:
D9 +24V switched ON
D10 +5V switched ON

Internal power status LEDs:
D11 +5V input OK
D13 +1.25V OK
D14 +1.2V PLL OK
D15 +1.8V OK
D16 +2.5V OK
D17 +2.1V OK

R3200 TEST PINS:
None

R3200 BLOCK DIAGRAM



R3310 IO1 (Input/Output 1)

R3310 DESCRIPTION:
Drives the stepper motors and includes electronics for controlling the X-ray generator.
Includes an FPGA integrated circuit and embedded SW.

R3310 LOCATION:
In the top part of the rotating unit.

R3310 FUNCTIONS:
100Mb Ethernet for internal communication.
Detector motor control signalling.
X-motor control signalling.
Collimator motor control signalling.
Slit motor driving.
Position laser driving.
Exposure button interface.
X-ray generator control.
X-ray back-up timer.
X-ray warning alarm.
Rotation encoder (dual phase).

R3310 INPUTS:
+28Vdc, mainly for motors
+5V, for logic

R3310 FUSES:
None

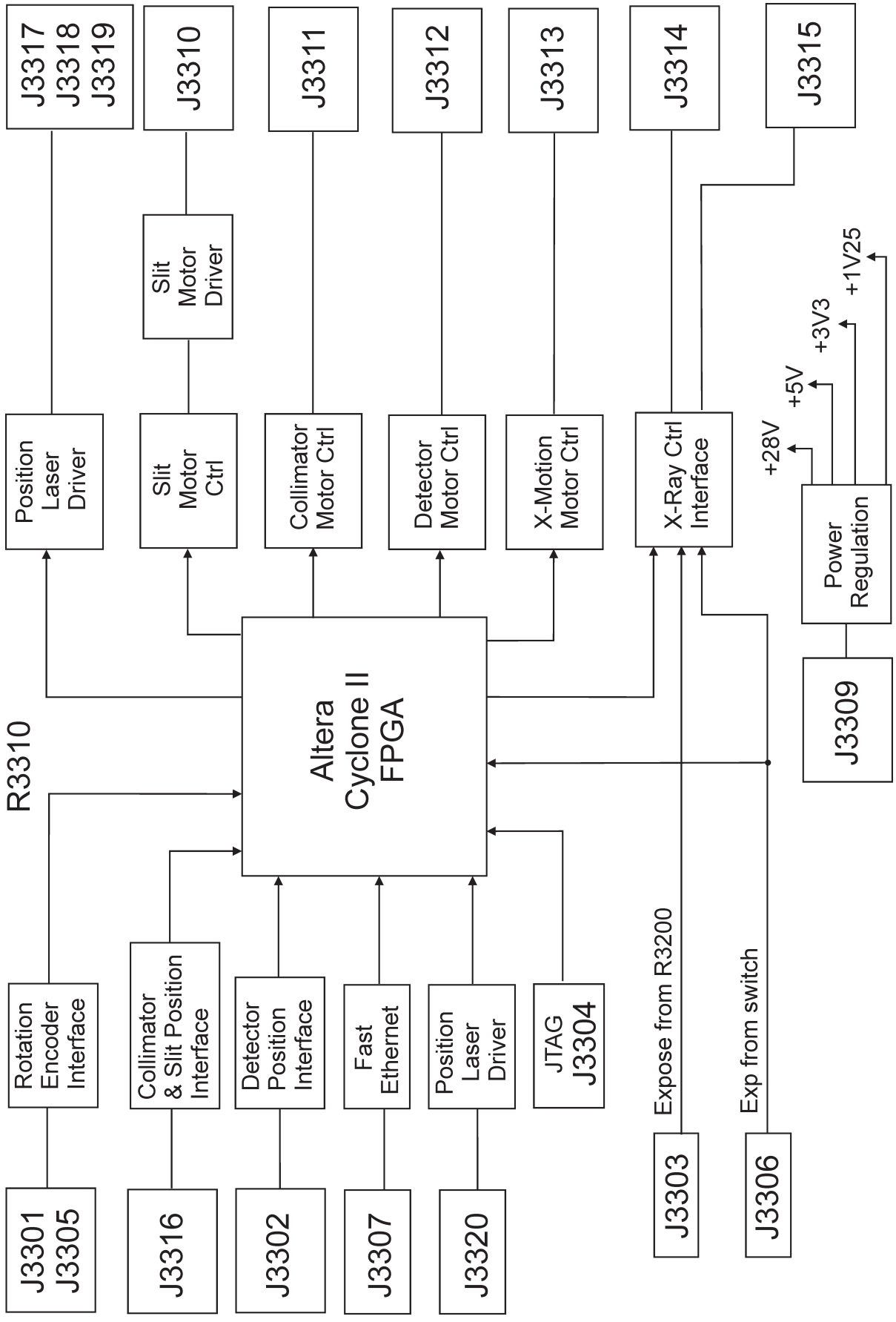
R3310 INDICATOR LEDS:

D1	+28V for motors (glowing means OK)	
D3	+1.25V	
D4	+3.3V	
D10	LINK	(light = link ok)
D11	ACT	(blink = traffic)
D12	SPEED	(on = 100MB)
D500	Exposure enabled	
D501	Preheat enabled	
D502	X-ray enabled	

R3310 TEST PINS:

TP6	Not for service use
TP7	GND
TP10	GND
TP11	POWGND
TP12	GND
TP13	GND
TP14	GND

R3310 BLOCK DIAGRAM



R3400 IO2 (Input/Output 2 Board)

WARNING!
Dangerous mains voltage on part of this board. The dangerous part is marked with crosshatched lines. LA1 also indicates when there is live voltage on the board.

R3400 DESCRIPTION:
Includes an FPGA integrated circuit and embedded SW.
Drives the AC-motor located in chair. The movement of the Z-motion is monitored by a magnetic HAL element (mounted to the motor) and high/low limit switches (inside of the chair lift mechanism).
The operation of external IO2 board is controlled via the internal Ethernet.

R3400 LOCATION:
In the front part of the base.

R3400 FUNCTIONS:
100Mb Ethernet for internal communication.
Remote control interface.
Emergency stop interface.
Z-motor safety logic and motor driving.
Chin motor driving.
Chin motor encoder (dual phase).
Y-motor driving.

R3400 FUSES:

F1	T5A 250V, 6 x 32

R3400 INDICATOR LIGHT:

LA1	Light indicates dangerous voltage (mains) ON = **DANGER**: mains voltage present OFF = No voltage

R3400 INDICATOR LEDS:

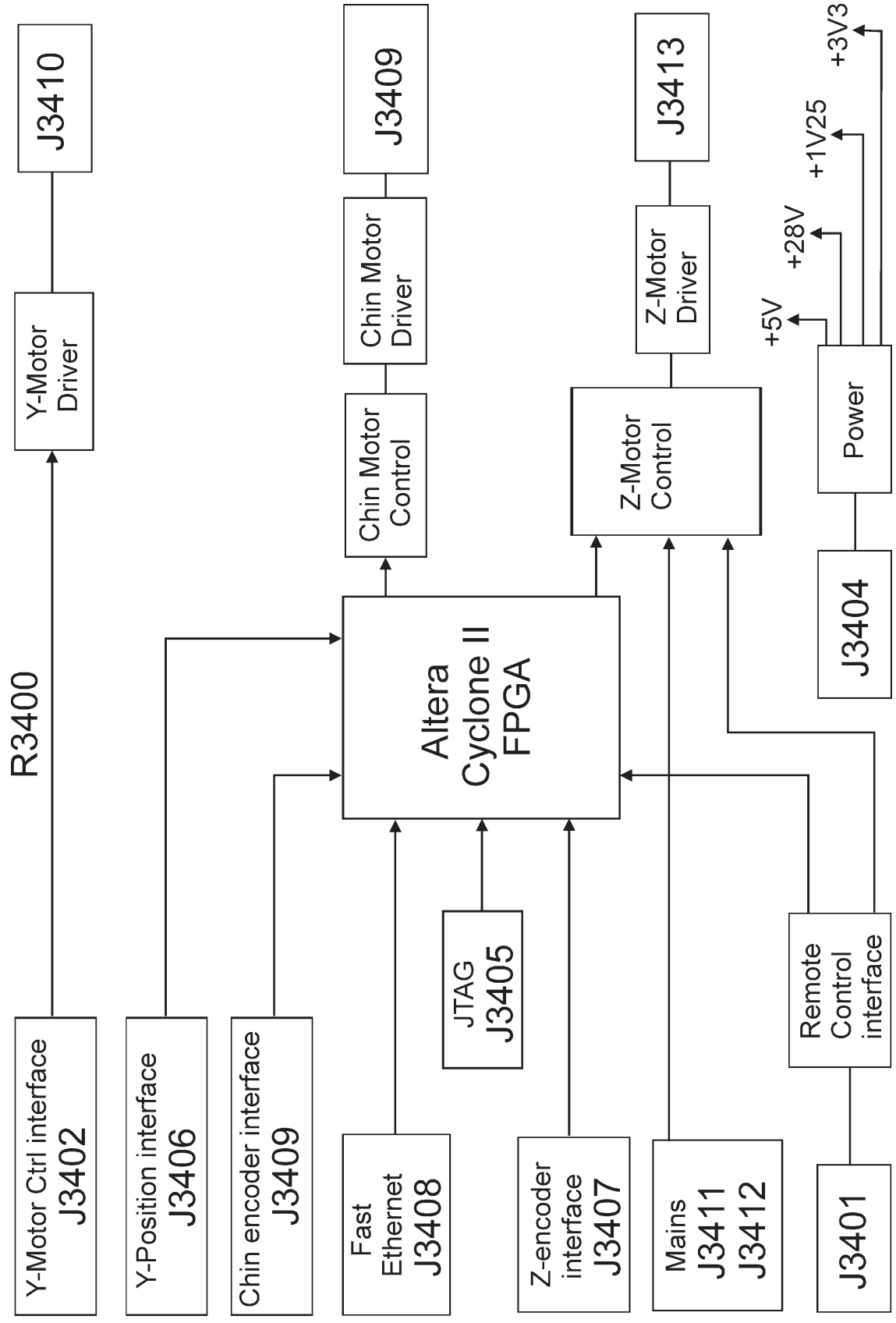
R3400 rel 6 and above

D1	3.3V
D2	1.25V
D3	Exposure switch pressed indicator
D4	Z-ENA_ETH
D5	Z-DOWN_ETH
D6	Z-UP_ETH
D15	Z-UP
D16	Z-DOWN
D18	Z-ENA
D20	Ethernet LINK OK
D21	Ethernet Speed (On=100MB, Off=10MB)
D22	Ethernet Transferring Activities
D30	Z-LOW LIMIT
D31	Z-UPPER LIMIT

R3400 TEST PINS:

TP1	GND
TP3	+3V3

R3400 BLOCK DIAGRAM



R3500 CCD Power supply

R3500 DESCRIPTION:
Generates low power supply voltages for the panoramic CCD sensor.

R3500 LOCATION:
In the detector head.

R3500 CONTROLS:
CCD power enable from the R3200 CPU.

R3500 INPUTS:
+28Vdc, mainly for motors
+5V, for logic

R3500 OUTPUTS:
-9Vdc
+3Vdc
+3.3Vdc
+5Vdc
+15Vdc

R3500 FUSES:
None.

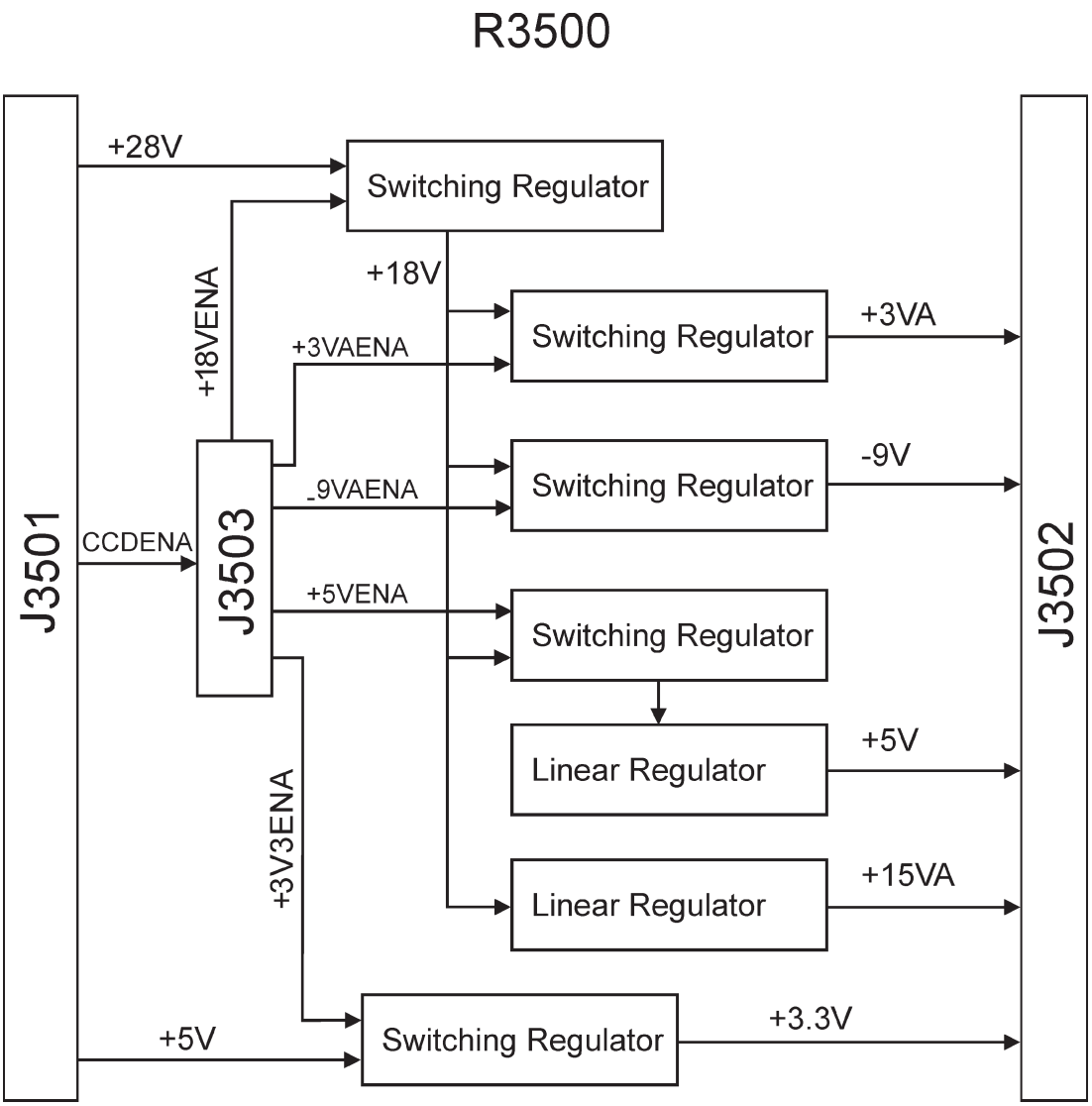
R3500 INDICATOR LEDS:

D9	+3V3
D10	+15VA
D11	+3VA
D12	-9VA
D13	5.1V

R3500 TEST PINS:

TP1	GND
TP2	GND
TP3	GND
TP4	GND

R3500 BLOCK DIAGRAM



R3710 X-ray Power supply

WARNING!
Dangerous mains voltage on part of this board. LA1 also indicates when there is live voltage on the board.

IMPORTANT NOTE:
Some earlier units use R3700 and not R3710. Replace R3700 with R3710. In addition if R3700 is replaced also replace R3800 with R3810.

R3710 DESCRIPTION:
Generates the voltages for the R3810 X-ray Generator.

R3710 LOCATION:
In the tubehead assembly.

R3710 FUSES:

F1	T2A 250V
F2	FF8A 500V
F3	T1A 250V

R3710 INDICATOR LIGHTS:

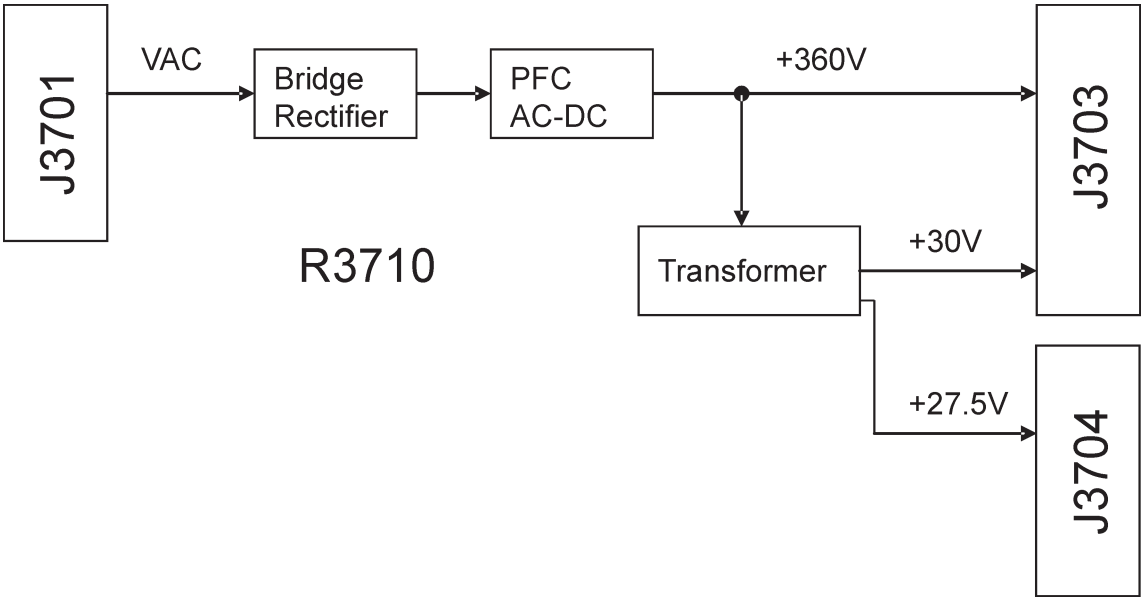
LA1	Light indicates dangerous voltage (mains) ON = **DANGER:** Mains voltage present OFF = No voltage

R3710 INDICATOR LEDS:

D13	+27V5

R3710 TEST PINS:
None.

R3710 BLOCK DIAGRAM



R3810 X-ray generator

WARNING!
Dangerous mains voltage on part of this board. The dangerous part is marked with crosshatched lines. LA1 also indicates when there is live voltage on the board.

IMPORTANT NOTE:
Some earlier units use R3800 and not R3810. Replace R3800 with R3810. In addition if R3800 is replaced also replace R3700 with R3710.

R3810 DESCRIPTION
The board has two main functions.
To generate 360Vp-p AC voltage for tubehead from the mains supply voltage, 230 VAC, and to generate the filament voltage for the tubehead and the feedback signals.

R3810 LOCATION:
In the tubehead assembly.

R3810 FUSES:
None.

R3810 INDICATOR LIGHT:

LA1	Light indicates dangerous voltage (mains) ON = **DANGER**: mains voltage present OFF = No voltage

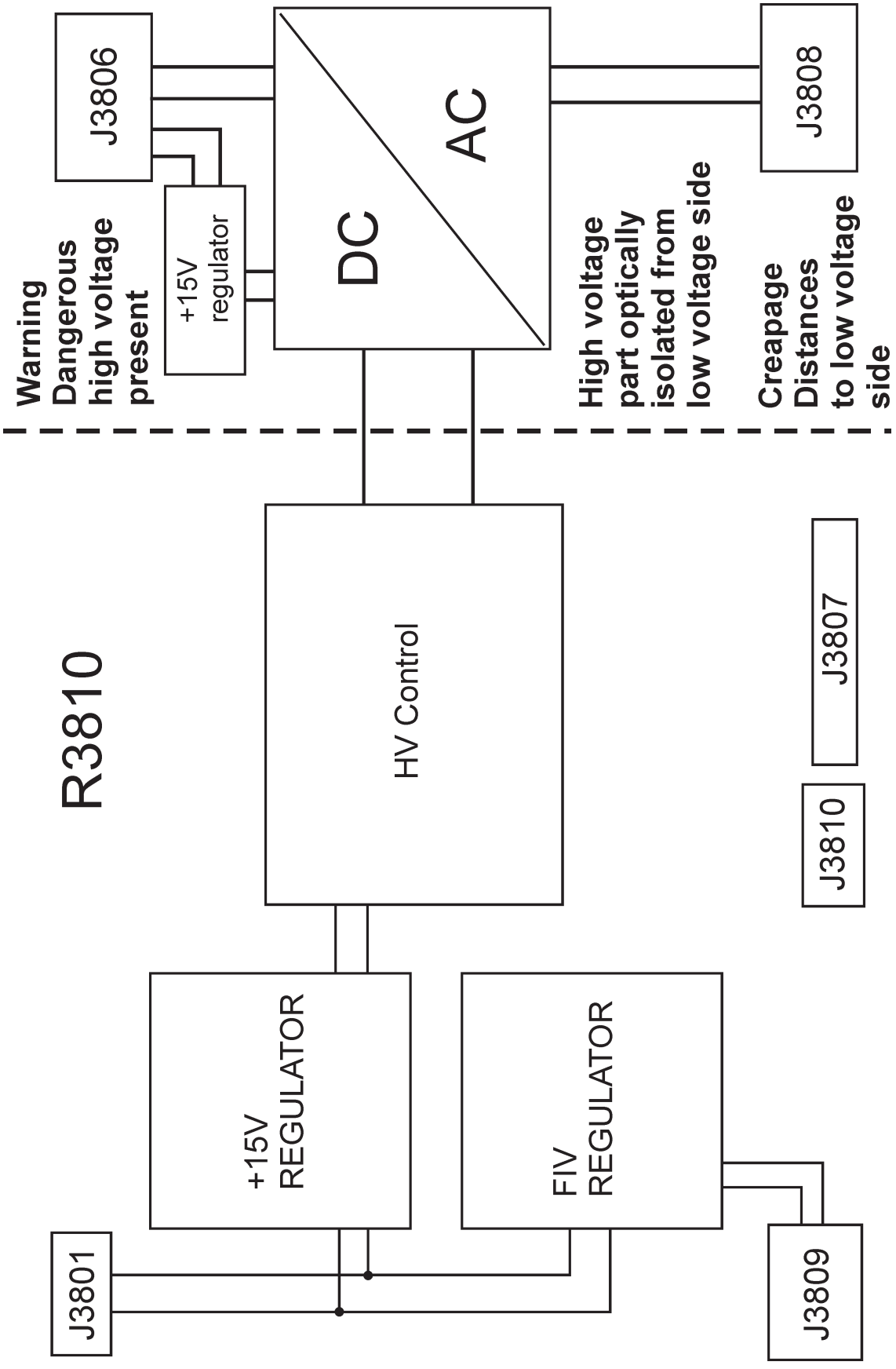
R3810 INDICATOR LEDS:

D1	FIV Filament power supply.
D2	+15V
D3	PREH
D30	HVGND
D31	EXP (3D flashing, pan constant)
D32	FAIL

R3810 TEST PINS:
Warning!
Test pins TP1-TP4 have galvanic connection to mains voltage!

TP1	15V	+15V when power is on (TP1 to TP2)
TP2	HVGND	
TP3	FETAD	Pulses appear when taking exposure, approx. 15Vpp (TP3 to TP2)
TP4	FETBC	Pulses appear when taking exposure, approx. 15Vpp (TP4 to TP2)
TP5	FAN OVERRIDE (Not in use)	
TP6	EXPENA	Controls radiation, 0 = radiation OFF, approx. +15V=radiation ON
TP7	KVFB	Feedback from tube voltage, scale 1V=20kV exp ON
TP8	KVREF	Reference voltage for tube voltage, scale 1V=20kV exp ON
TP9		Not for service use
TP10	GND	Ground point, similar to TP16, for TP5-TP15 measurements
TP11	PREHREF	Reference voltage for mA preheat, varies from 1.2V to 1.8V
TP12	MAREF	Reference voltage for tube current, 1mA=0.28V -> 8mA=2.25
TP13	MAFB	Feedback from tube current, 1mA=0.28V -> 8mA=2.25
TP14		Not for service use
TP15	PREHEAT_FB	Depends on mA value, 250mV->750mV during preheat time, during exposure, less than 350mV.
TP16	GND	

R3810 BLOCK DIAGRAM



R3900 Mains connector

WARNING!
Dangerous mains voltage on part of this board. The dangerous part is marked with crosshatched lines. H1 also indicates when there is live voltage on the board.

R3900 DESCRIPTION:
The main function is to distribute AC voltage from the mains switch (main power supply) to the:
- mains transformer
- to R3400 IO2
- to R3710 X-ray power supply
- to GUI PC power supply (some versions are non isolated and some are isolated)

It is also used as a connector board for EXP signal and a relay for the warning light.

R3900 LOCATION:
In the electronics cabinet.

R3900 FUSES:

F1	T2A/250V 6 x 32
F2	Unused

R3900 INDICATOR LIGHT:

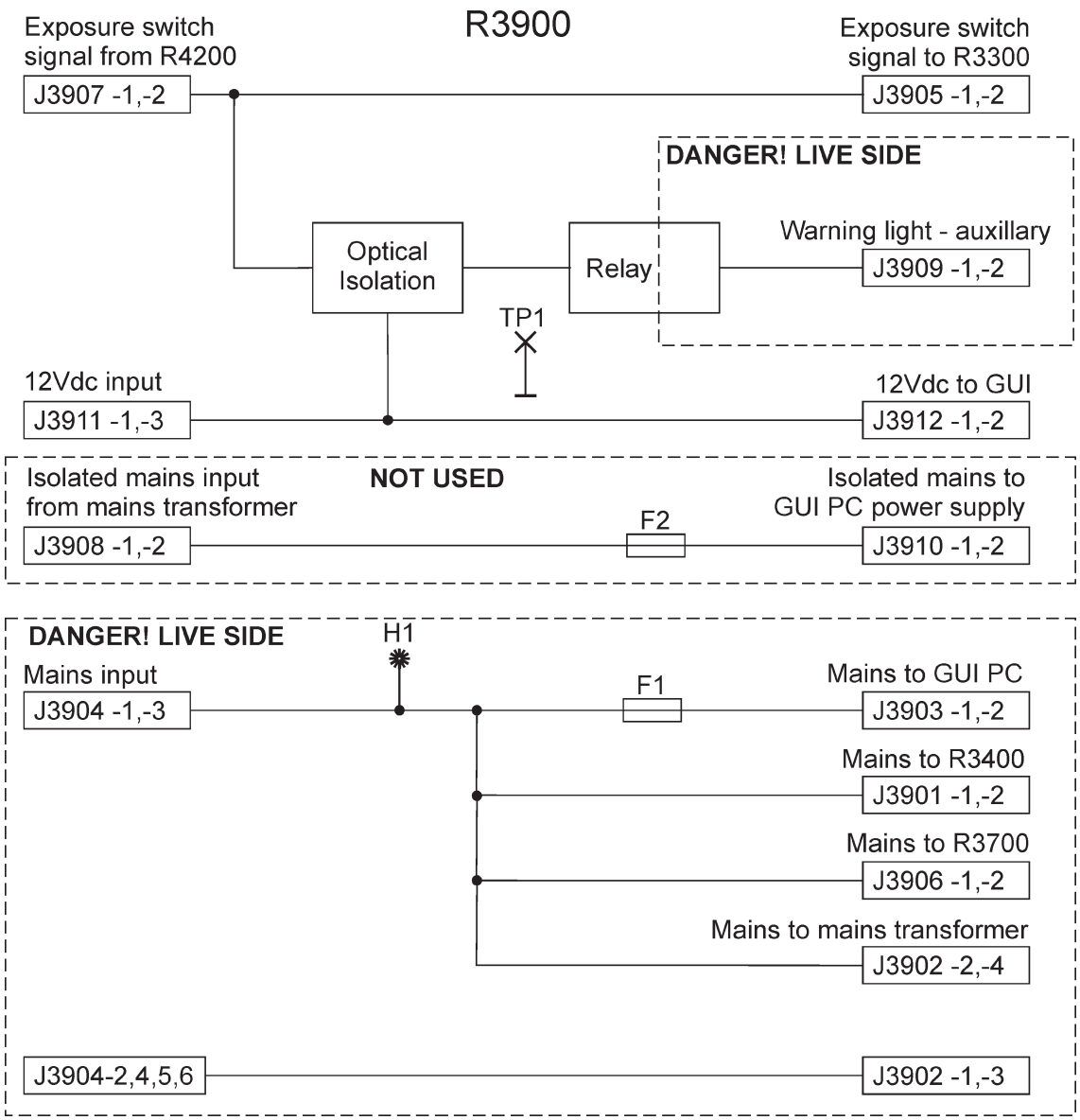
H1	Mains Voltage	Indicates the existence of the mains voltage. Off = Voltage less than 65V On = **DANGER!** Voltage more than 65V

R3900 INDICATOR LEDS:
None.

R3900 TEST PINS:

TP1	Ground	Test point for secondary side grounding. **NOTE!** Not suitable for measuring the mains side grounding.

R3900 BLOCK DIAGRAM



R4000 Connector

R4000 DESCRIPTION:
Distributes the low DC supply signals to R3200 CPU, R3300 IO1 and R3500 CCD power supply.

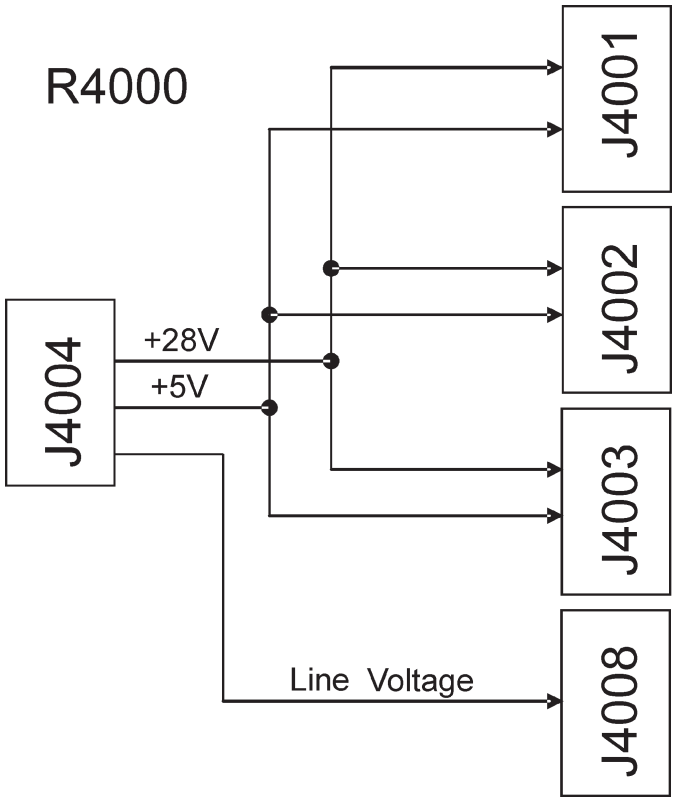
R4000 LOCATION:
In the detector head.

R4000 FUSES:
None.

R4000 INDICATOR LEDS:
None.

R4000 TEST PINS:
None.

R4000 BLOCK DIAGRAM



R4100 Rotator opto

R4100 DESCRIPTION:
There are four of these boards in the unit. They monitor the position of rotating unit motor.

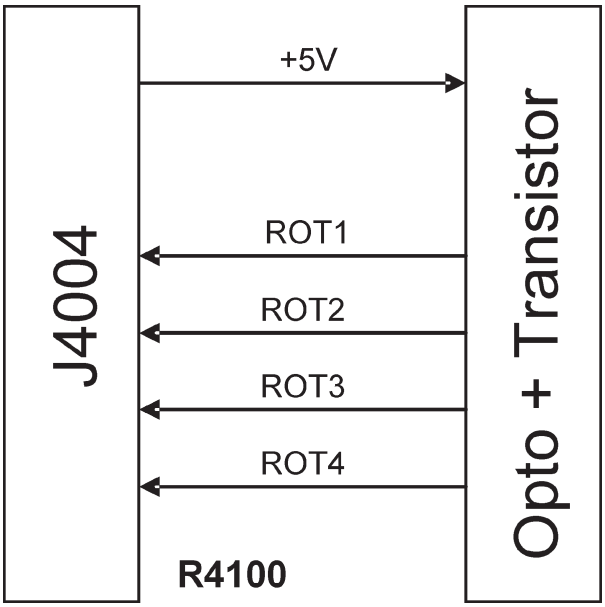
R4100 LOCATION:
In the top part of the rotating unit.

R4100 FUSES:
None.

R4100 INDICATOR LEDS:
None.

R4100 TEST PINS:
None.

R4100 BLOCK DIAGRAM



R4200 Opto sensor

R4200 DESCRIPTION:
There are two of these boards in the unit. One monitors the position of collimator motor and the other the detector motor.

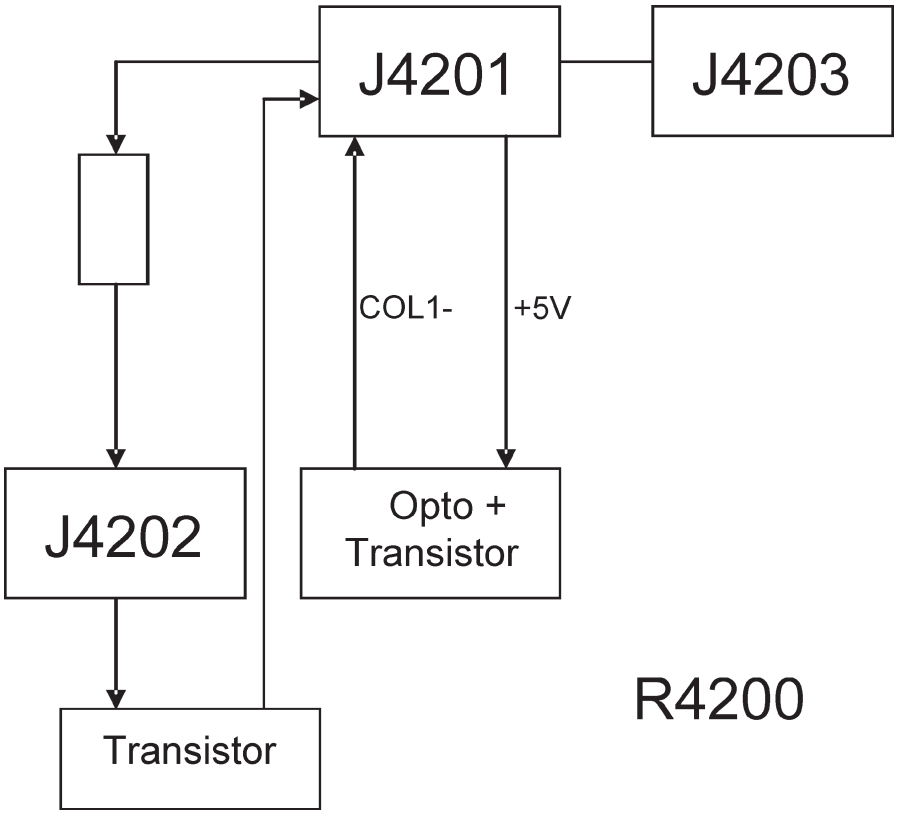
R4200 LOCATION:
One in the tubehead assembly.
One in the detector head of the rotator for the detector swap.

R4200 FUSES:
None.

R4200 INDICATOR LEDS:
None.

R4200 TEST PINS:
None.

R4200 BLOCK DIAGRAM



R4300 Remote control

R4300 DESCRIPTION:
The control used by the user to operate the unit.

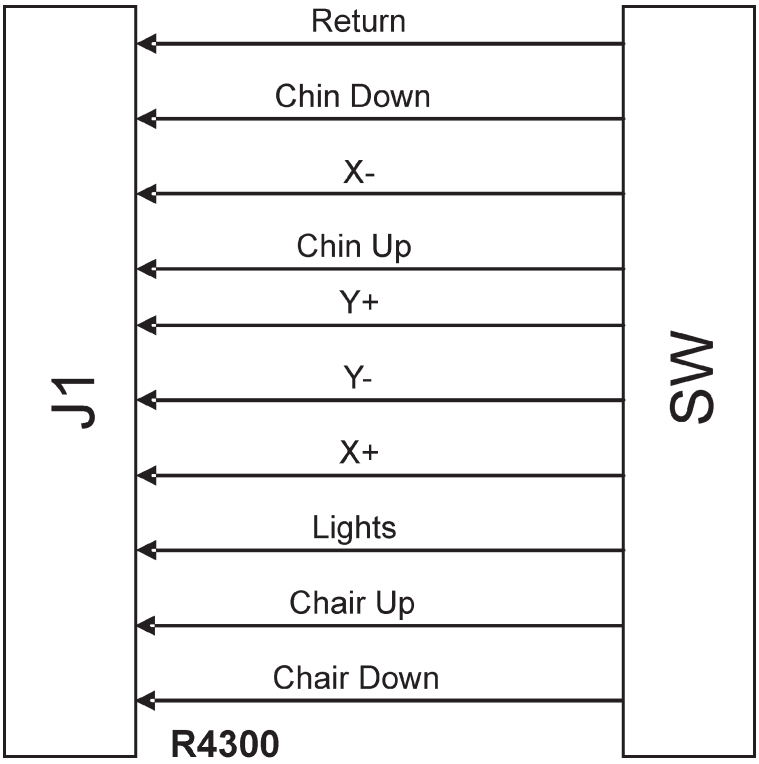
R4300 LOCATION:
In the remote control.

R4300 FUSES:
None.

R4300 INDICATOR LEDS:
None.

R4300 TEST PINS:
None.

R4300 BLOCK DIAGRAM



R4400 Panel data adaptor

R4400 DESCRIPTION:
Data adaptor board between R3200 and the 3D sensor.

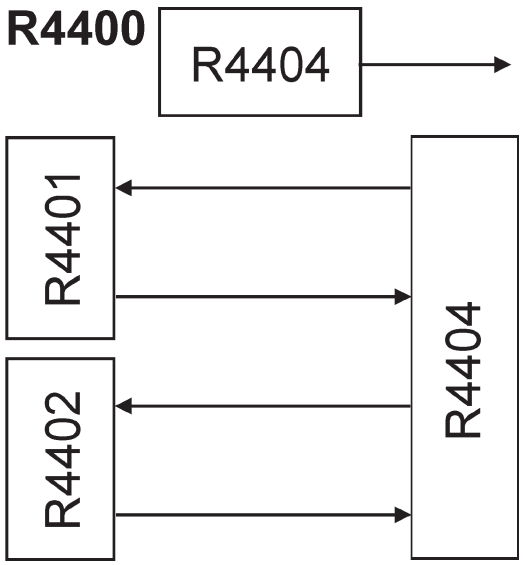
R4400 Location
Rotating unit (detector head), attached to R3200..
Type - satellite board.

R4400 FUSES:
None.

R4400 INDICATOR LEDS:
None.

R4400 TEST PINS:
None.

R4400 BLOCK DIAGRAM



N4600 Opto sensor

N4600 DESCRIPTION:
There are two of these boards in the unit. One monitors the position of Y-motor and the other the position of the of X-motor. The board comprises three optical switches that generate sensor signals.

N4600 LOCATION:
One in the upper shelf.
One in the chair base.

N4600 FUSES:
None.

N4600 INDICATOR LEDS:
None.

N4600 TEST PINS:
None.

R4710 3D panel power supply

R4710 DESCRIPTION:
Generates the low voltages for the 3D sensor.
The board regulates the voltages, 8V analog to 5V analog and 8V digital to 5V digital. There are also output/enables in the circuit. One is external and one is internal. The external O/E is connected to the 5V digital regulation circuit and internal O/E is connected from the 5V digital output to the 5V analog enable.

R4710 LOCATION:
In the detector head.

R4710 CONTROLS:
Panel power enable from the R3200 CPU

R4710 INPUTS:
+8Vdc (digital side)
+8Vdc (analog side)
±9Vdc (analog side)

R4710 OUTPUTS:
+5Vdc (digital side)
+5Vdc (analog side)
±7.5Vdc (analog side)

R4710 FUSES:

F1	315LA	±9V inputs
F2	315LA	±9V inputs

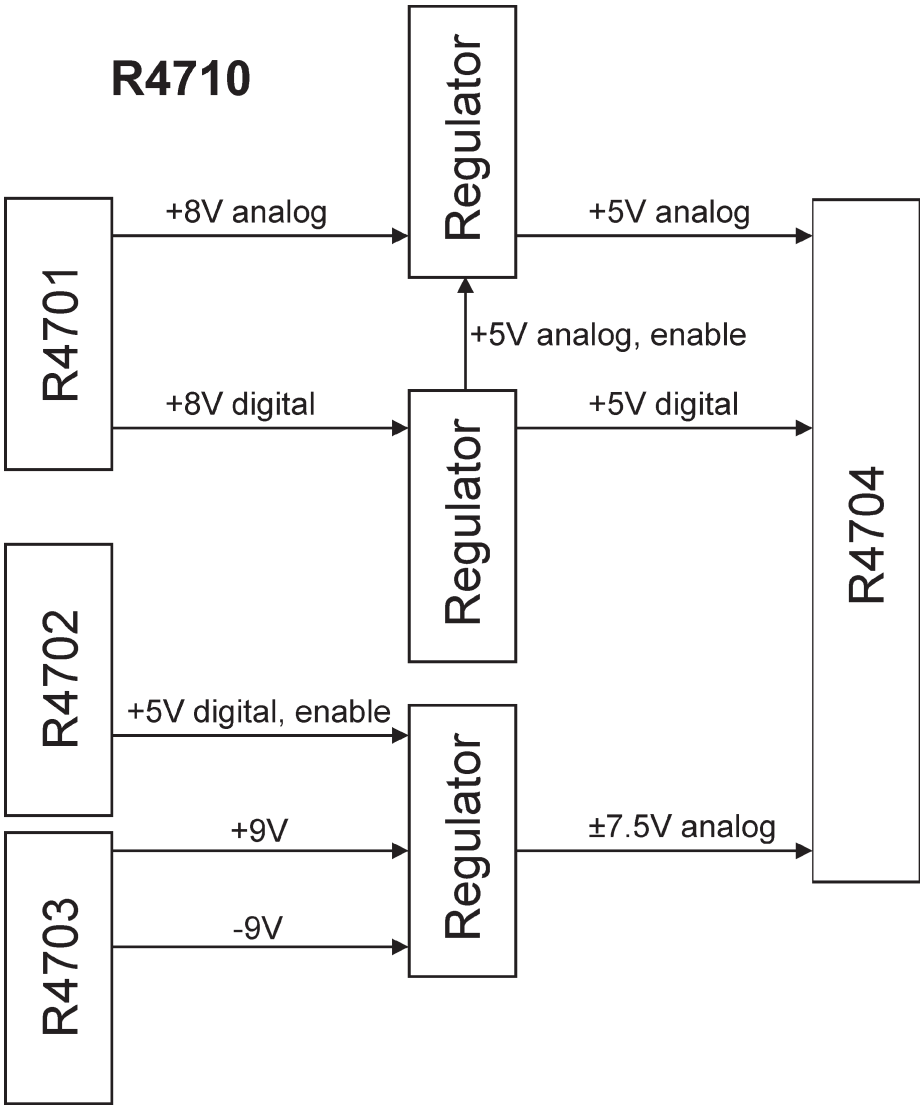
R4710 INDICATOR LEDS:

D3	+5V Dig
D4	+5V Ana
D9	+7.5V Ana
D11	-7.5V Ana

R4710 TEST PINS:

D4	+5V Ana

R4710 BLOCK DIAGRAM



R4800 Chin rest opto

R4800 DESCRIPTION:
It monitors the position of the patient support assembly motor. The board comprises two optical switches that generate sensor signals.

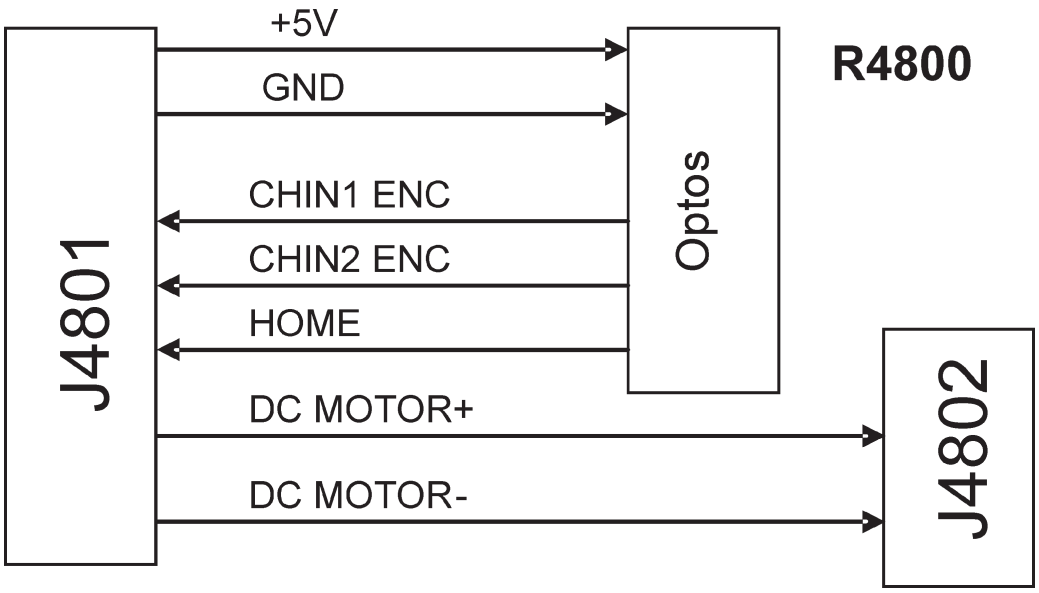
R4800 LOCATION:
In the patient support assembly.

R4800 FUSES:
None.

R4800 INDICATOR LEDS:
None.

R4800 TEST PINS:
None.

R4800 BLOCK DIAGRAM



R4910 Panorama interface

R4910 DESCRIPTION:
There are two of these boards in the unit. They serve as an interface between the panoramic sensor and R3210 CPU.

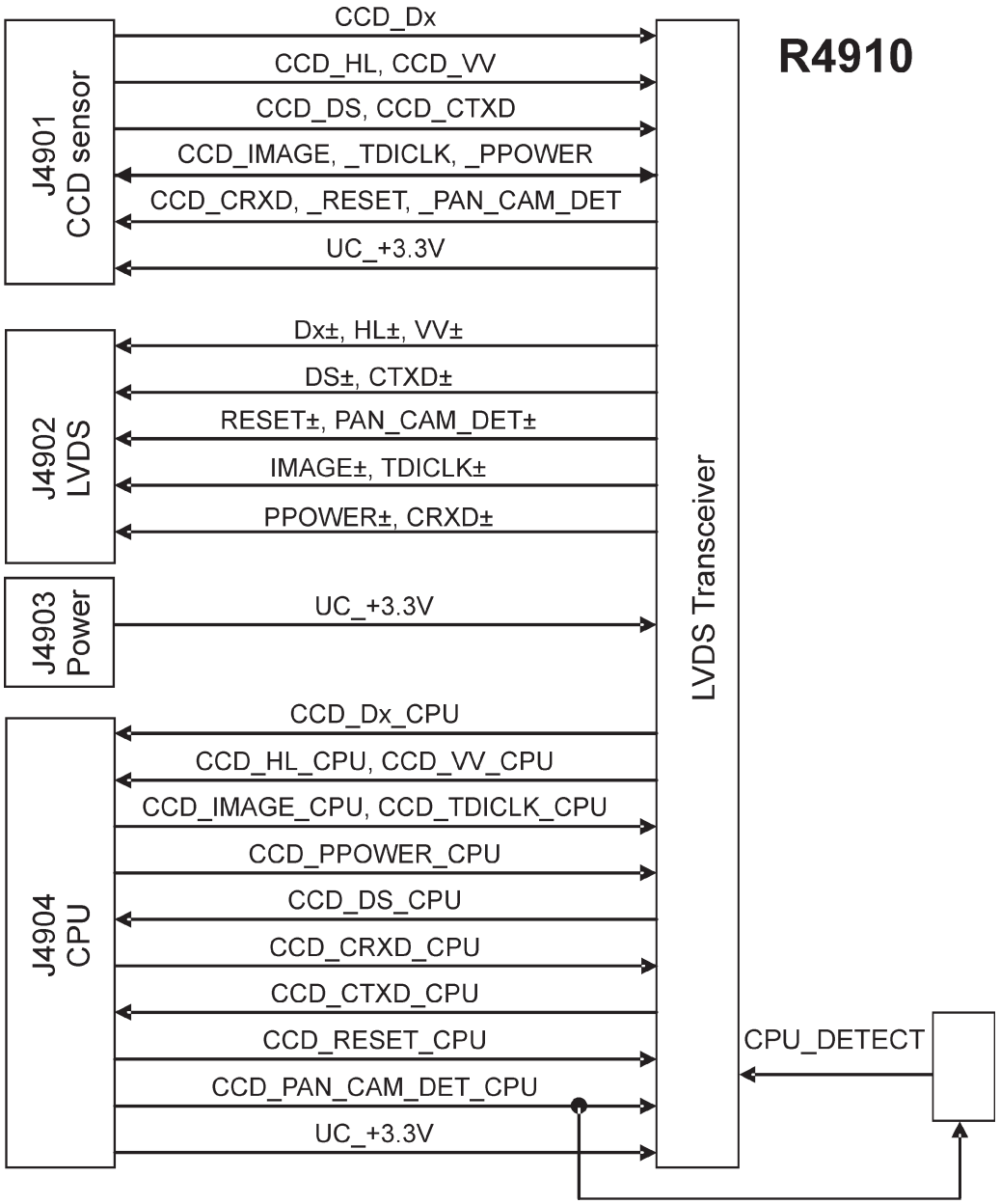
R4910 LOCATION:
Both are in the detector head one in the pan sensor arm and the other attached to the R3200 CPU.

R4910 FUSES:
None

R4910 INDICATOR LEDS:
None

R4910 TEST PINS:
None

R4910 BLOCK DIAGRAM



R5100 3-phase stepper driver

R5100 DESCRIPTION:
There are four of these boards in the unit. The inputs are current driven and connected to the logic boards R3200 CPU and R3300 IO1.

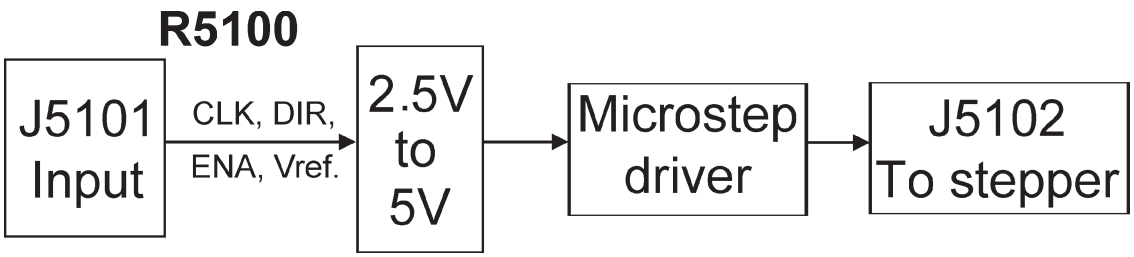
R5100 LOCATION:
One in the detector head, one in the tubehead assembly, one in the upper shelf, one in the upper part of the rotating unit.

R5100 FUSES:
None.

R5100 INDICATOR LEDS:
D1 +5V
D2 +28V

R5100 TEST PINS:
NOTE:
Some earlier versions of this board did not have test pins.
GND
Vref
clk
ENA

R5100 BLOCK DIAGRAM



R5200 ESD Protection

R5200 DESCRIPTION:
Transforms the connector formats. ESD protection is also on this board

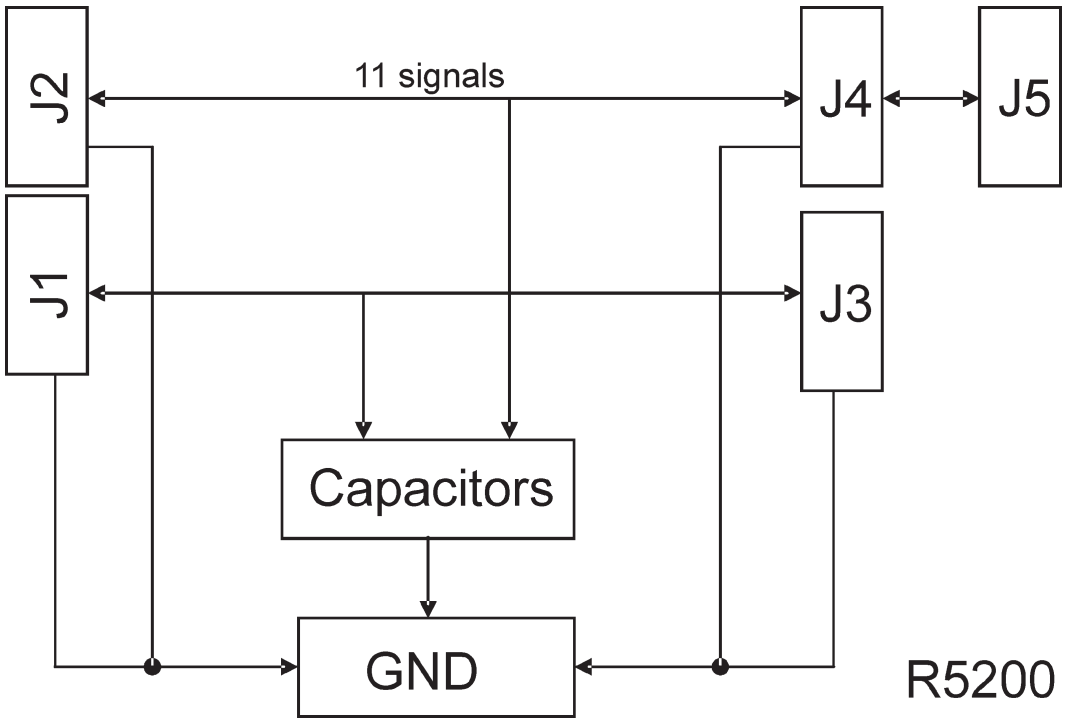
R5200 LOCATION:
In the electronics cabinet.

R5200 FUSES:
None.

R5200 INDICATOR LEDS:
None.

R5200 TEST PINS:
None

R5200 BLOCK DIAGRAM



R5310 Panel raw power supply

R5310 DESCRIPTION:
Generates +8V low voltage for the analog side of the 3D sensor power chain.
NOTE! The +8V is distributed to the R4710 3D panel power supply, which re-regulates it to +5V and ±9Vdc and distributes these voltage to the 3D sensor.

R5310 LOCATION:
In the electronics cabinet.

R5310 INPUTS:
12Vac

R5310 OUTPUTS:
+8Vdc (analog side)
±9Vdc (analog side)

R5310 FUSES:

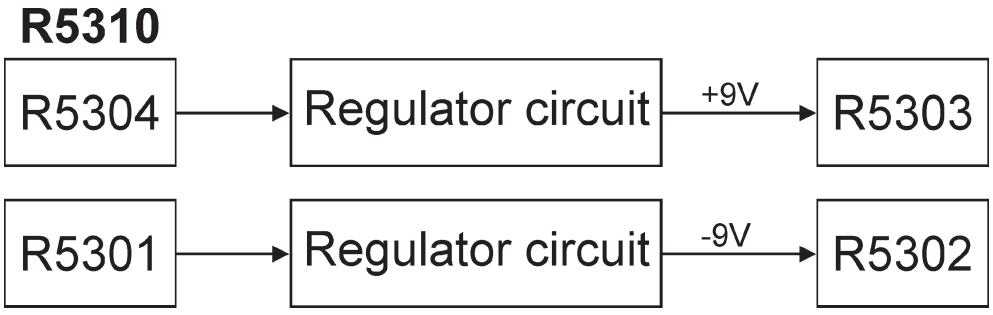
F1	T2.5A/250V 6 x 32
F2	T0.5A/250V

R5310 INDICATOR LEDS:

H1	12Vac
H2	+8VDL analog
H3	+9Vdc analog
H4	-9Vdc analog

R5310 TEST PINS:
None.

R5310 BLOCK DIAGRAM



3D Detector

3D DETECTOR DESCRIPTION:
3D image acquisition.

3D DETECTOR LOCATION:
Rotating unit (detector head)

3D DETECTOR FUSES:
None.

3D DETECTOR INDICATOR LEDS:
None.

Ethernet switch/router

PURPOSE:
Ethernet signalling

LOCATION:
In the electronics cabinet.

FUSES:
None.

INDICATOR LEDS:
D1 - D5
OFF = no connection
ON = link connection OK (no traffic)
FLASH = link connection OK (traffic)

Panoramic Detector (CCD)

Panoramic Detector description:

Panoramic image acquisition.

Panoramic Detector location:

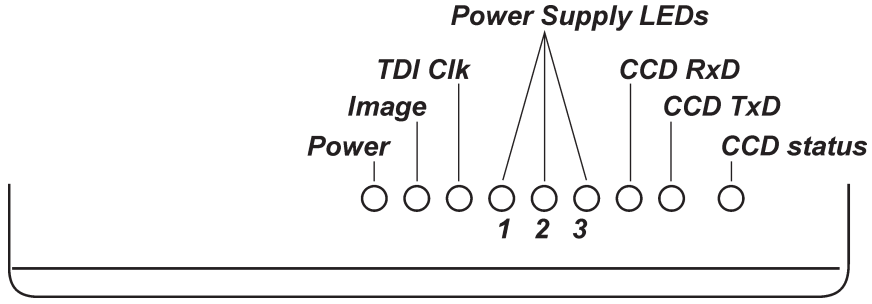
Rotating unit (detector head)

Panoramic Detector fuses:

None.

Panoramic Detector Indicator LEDs:

On the rear of the CCD sensor there are a number LEDs that indicate the status of the panoramic detector (CCD).



- **CCD status LED** (three colour)
  It indicates that the CCD is connected, all the software has been downloaded and it is ready to take and image.
  Green, in stand-by mode (power signal not active).
  Green flashing, mode conflict, e.g. a pan exposure has been selected but the CCD sensor is not in the correct position.
  Yellow, image capture mode (power on).
  Red, in position but not yet ready, SW is being loaded.
  Red flashing, fatal SW error / communication routine failure after an image has been taken.
  NOTE:
  The LED will flash red when in the service mode.

- **CCD TxD** and **CCD RxD LEDs** (yellow) serial communication. In normal operation they flash intermittently.
  They indicate communication activity. If CCD RxD is off (passive CCD sensor), CCD TxD will also be off. If CCD TxD is off, CCD RxD is on and the CCD status LED flashes during and after image capture it indicates that the CCD sensor tried to receive the image, but the transmit communication routine failed.

- **Power Supply LEDs** (yellow) indicate the different voltages required by the CCD sensor. The IC in the CCD sensor monitors the voltages and activates the LEDs accordingly. The software set limits for the various supply voltages. The LEDs come on during image capture.

  LED 1. +3.3V and +1.8V LEDs
  Supply voltages for the CCD clock controlling FPGA. The +3.3V is generated in DIB from VCC_+5V.
  The +1.8V step down is generated in camera board from +3.3V (from DIB).
  LIMITS:
  +3.3V between +3.0 and +3.6V
  +1.8V between +1.71V and +1.89V.

  LED 2. Analog +5V LED
  DIB generates this voltage from VSP_+5V
  Supply voltage for AD-converters
  LIMITS
  between +4.5V and +5.5V

  LED 3. +15V, +3V and –9V LED
  DIB generates these voltages from VAP_+18V
  CCD gate voltages
  LIMITS:
  +15V between +13.5V to +16.5V
  +3V between +2.4V and +3.6V
  -9V between -9.92V and -9.17V

Another required voltage is cam_permanent_+5V (signal name on the DIB board). It is used to power the IC. If this voltage is missing all the LEDs will be off.

- **TDI clk LED** (yellow). Indicates that the clocking frequency of CCD is available.
  LED Off - TDI frequency is between 0...50Hz
  LED On - TDI frequency is between 100 Hz...1kHz
  LED Flashing - TDI frequency is between 50...100Hz or above 1kHz.

- **Image LED** (yellow). Indicates pimage/cimage signal activity. It tells detector A/D-converter to sample image data according to the TDI frequency.

- **Power LED** (yellow) Indicates that ppower/cpower signal is active. Switching regulators of DIB board are enabled after ppower/cpower signal becoming active.

L1400 CCD-Filter board

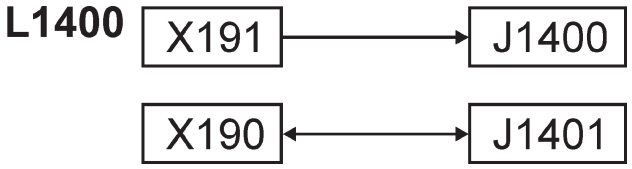
L1400 DESCRIPTION:
EMC filtering of the CCD panel board.

L1400 LOCATION:
Rotating unit (detector head) attached to the CCD panel board.

L1400 FUSES:
None.

L1400 INDICATOR LEDS:
None.

L1400 BLOCK DIAGRAM



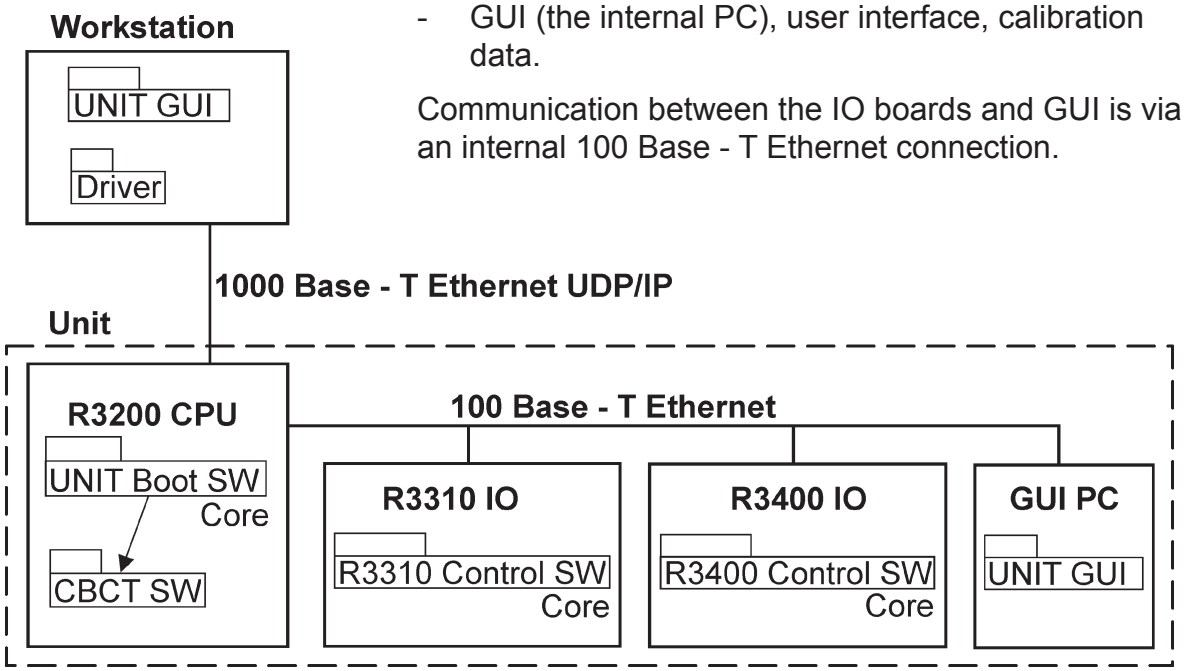
4. Firmware description

4.1 Overview

The firmware is located on four components:

- R3200 CPU, main control, image acquisition, Ethernet interface
- R3310 IO1, rotating unit movements and X-ray control
- R3400 IO2, chair control
- GUI (the internal PC), user interface, calibration data.

Communication between the IO boards and GUI is via an internal 100 Base - T Ethernet connection.



4.2 Detailed View

R3200 CPU

Executes the main and boot SW of the unit.

Boot software

Loads the main firmware into the RAM and starts it. Handles the initial unit firmware loading and boot mode updates.

Main software

Controls and coordinates unit movements, exposure, image acquisition and transfer.
The image data acquired during image capture are stored in the internal memory of the unit. After image acquisition the image data are transferred to the workstation using the external 1000 Base - T Ethernet UDP/IP Ethernet.

It also handles multiple connections and up to five clients (drivers, S2Terminal or replicate PC GUIs) can be connected to the unit via the external Ethernet.

It also offers firmware upgrade services for itself and software upgrade for GUI. It also offers core (FW) update service for R3310 IO1 and R3400 IO2 as there is no direct connection from the driver of the S2Terminal to these two boards.

R3310 IO1 software

Controls noncritical movements, X-ray generator IO etc.

R3400 IO2 software

Controls noncritical movements, IO, lights etc. Communicates with CPU over a 100Base-T interface.

GUI software

Holds the unit calibration data that is transferred to the R3200 CPU during start up.

4.3 Operating modes

Imaging mode

The usual operation mode. X-ray imaging is allowed when patient study is started.

Test mode

Same as the normal imaging mode, except that the X-ray generator is disabled.
The image is grabbed but not sent to the driver.
Tests the imaging chain.

CAUTION
Using this mode will delete the last image taken (temporarily stored in the unit memory) making it nonrecoverable.
Useful when problems with movements, image grabbing etc. need to be investigated.

Test mode activation/deactivation

Using the GUI
Activated from GUI by touching the ‘T’ key.
The T icon on the GUI will change to the active state.
Deactivate by touching the ‘T’ key again.

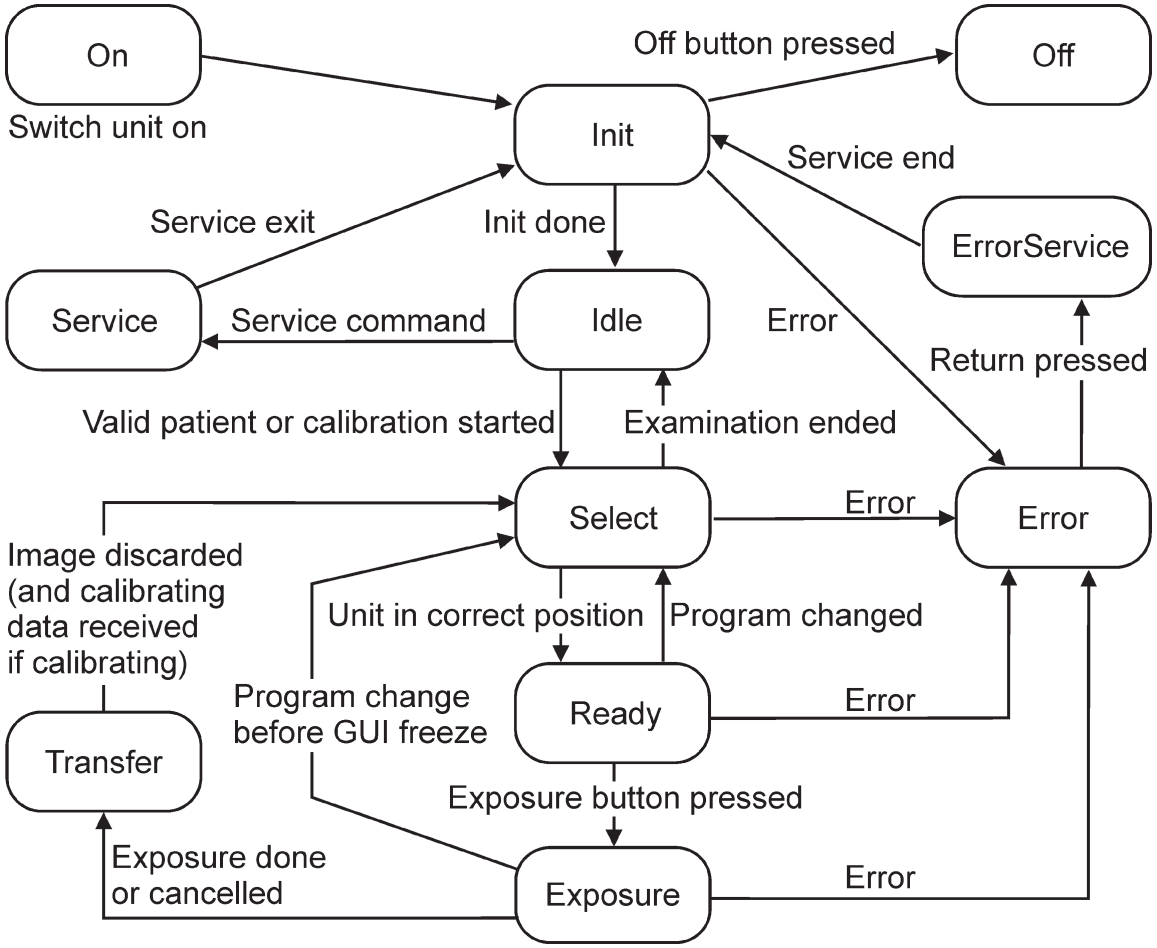
Using the s2terminal
Activate by entering the command: ‘testmode 1’.
Deactivate by entering the command: ‘testmode 0’

4.4 Firmware states

IO cards only have one state. The IO cards wait for commands from the main CPU. After they receive a command they execute the command and send an acknowledgment of its execution to the main CPU. CPU board (R3200) has several states that perform various checks during operation of the system.

R3200 states

R3200 control state machine has the following states:
- Init (Initialization)
- Idle
- Select (Program select)
- Ready
- Exposure
- Transfer (Image transfer)
- Error
- Error Service
- Off (emergency stop!)



Init (initialization) state

During the initialization state the unit carried out several initializations and checks as follows:

- detects the IO boards
- initializes the generator
- initializes the collimator
- initializes the image buffer and calibration data
- checks states of the detectors
- checks the state of the exposure button
- initializes the movements

Most of the essential functionality of the unit is tested during the initialization state.
Note, however, the x-ray generator is not tested.

Idle state

The unit is waiting for an examination to be started by the driver.
The **service** state can be entered during this state
The unit will enter the **error** state if a system error occurs.

Select (program select) state

The unit initializes the selected program and enters the **ready** state when system is ready to take an exposure.
If the examination is ended, the unit will return to the **idle** state.
The unit will enter the **error** state if a system error occurs.

Ready state

The unit is waiting for the exposure button to be pressed. Once it notices that the button has been pressed the **exposure** state is entered.
If the exposure program is changed when the unit is in the **ready** state, the unit will revert to the **select** state.
The unit will enter the **error** state if a system error occurs.

Exposure state

The unit carries out the selected exposure program and, when completed, proceeds to the **transfer** (image transfer) state.
The exposure button is monitored during the exposure. Rotation and detector movements are also monitored. If a fatal error occurs and no image has been captured the unit will enter the **error** state. If an image has been captured the unit will enter the **transfer** state and transfer the image to PC and then enter the **error** state.

Transfer (image transfer) state

The unit waits for the image transfer to be completed. Any calibration actions are handled if the exposure program was a calibration program.
The exposure counter is updated.
After the driver has received the image it releases it. It makes sure that exposure button is released and after it has been the unit returns to the **select** state.

Error state

The unit will enter the **error** state whenever a system error is encountered. Movements and x-rays are stopped as a precaution. The error log is updated. Service state may be entered using the s2terminal for further diagnosis.

Service state

The **service** state (s2terminal) is entered by giving the **service** command when the unit is in the **error** state or **idle** state.

Off (Emergency) state

The emergency stop button status is active by the R3400 IO2.
The main R3200 CPU continuously polls the status of R3400 IO2 during normal operation.
If the emergency stop button is pressed it halts the system and blocks normal control of the unit. Only the GUI and Driver status messages are handled.
The GUI will notify the user that the button has been activated.
When the emergency stop button is released, the control firmware is restarted from scratch.

4.5 Generator modes

There are two generator modes:

- Pulsed mode for cone beam imaging
- Constant exposure for panoramic imaging

4.6 Firmware updating in the field

Refer to **s2terminal** section for information on how to do this

5. Imaging sequence

5.1 Powering up the Unit – Init

The unit initializes itself and then waits for the GUI PC to start up (it does not wait for PC or any optional remote GUI to respond).

Calibration data is transferred from the GUI PC to the R3200 CPU.

Encoders and movements are initialized – the user needs to press and hold down the chair down button (Z) until the initialization is complete.
The motor commands are from R3200 CPU and the pulses from R3310 IO1 and R3400 IO2.

Initialization start **Initialization end**

<table>
<tr><td colspan="6">Drive chair to home position. Z - movement. R3400 IO2.</td></tr>
<tr><td colspan="6">Drive patient support to home position. J - movement. R3400 IO2.</td></tr>
<tr><td colspan="2">Drive collimator to home position
C - mov. R3310 IO1</td><td colspan="4">Drive CCD detector to home position
D - movement. R3310 IO1</td></tr>
<tr><td colspan="6">Drive slit to home position. S - movement. R3300 IO1.</td></tr>
<tr><td></td><td colspan="5">Drive rotating unit</td></tr>
<tr><td></td><td>X - mov.
to home
R3310</td><td>X - mov.
to offset
R3310</td><td>Y - mov.
to home
R3400</td><td>Y - mov.
to offset
R3400</td><td>R - mov.
to home
R3310</td></tr>
</table>

5.2 Positioning the Patient

The motors are powered up.

GUI display is activated if it is in energy save mode.

Return button is enabled so the unit can be driven to the PIO position.

When the unit is in the PIO position the rest of the buttons on the remote control are enabled and can be used to move the chair, chin rest and rotating unit (X and Z) to position the patient.

The detector for the exposure program selected, 3D or pan, is powered on. If the panoramic mode is selected the panoramic detector is only enabled during imaging.

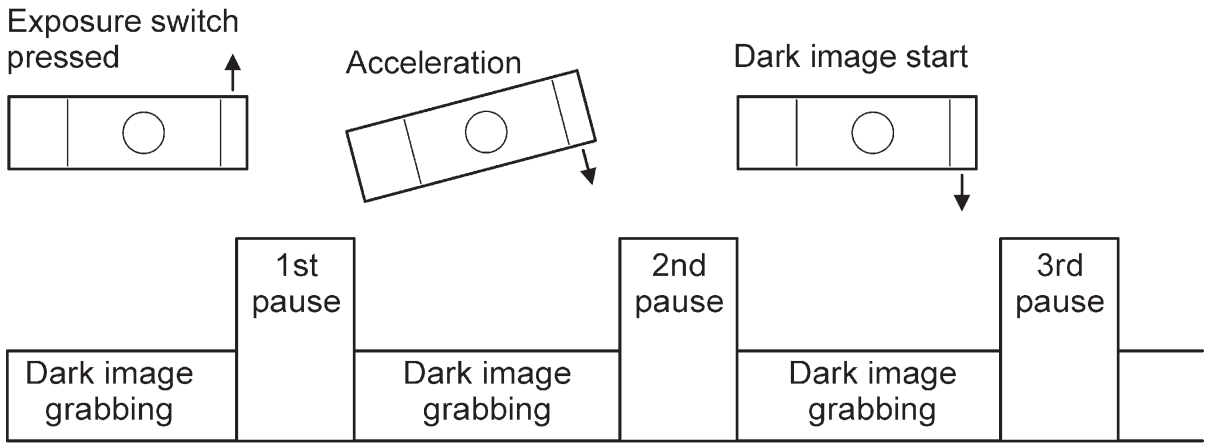
5.3 Exposure Start - no X-rays

The X-ray tube preheat current is enabled for a few seconds before the exposure starts.

Movements R-rotation, C-collimator, S-slit, and for pan exposure Y-chair , D-detector are started after preheat is enabled.

When the rotating unit passes the home optoswitch all the other optoswitches are activated and synchronized to the position of the home optoswitch.

Immediately after home position frame grabbing is started – first 20 dark images (slightly under 1s, depending on size of FOV) are taken without X-rays.

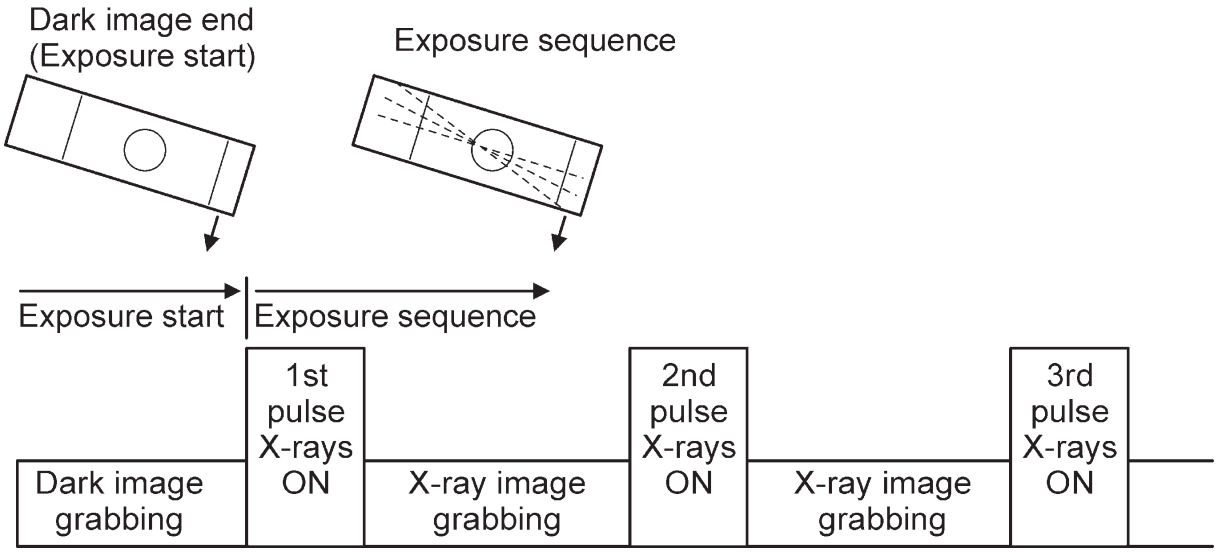


5.4 Exposure Sequence

X-rays ON (time depends on FOV) – no data grabbing.

X-rays OFF (time depends on FOV) – data grabbing performed.

The pulsing sequence is repeated for the specified number of frames that the FOV volume comprises – 225, 250, 300, 375 or 450 depending on the FOV selected.



5.5 Exposure sequence errors

The exposure sequence is stopped if:

- The rotating unit touches the patient so that its movement does not follow the predetermined path
- Exposure switch is released
- X-ray generator fails
- If 3D sensor stops delivering data (frame grabbing failure)

If more than 2/3 of the total number of images are captured after an error occurs, the 3D volume will be generated regardless of the system failure.
If less than 2/3 of the images are captured no image will be produced.

In the event of a CPU failure the parallel backup timer cuts off the radiation within 110% of predetermined exposure time.

5.6 Exposure End

Disable X-Rays.

Decelerate movements.

Allow return and chair down movements.

6. The s2terminal

The **s2terminal** service terminal application is a software tool that allows the operation of the unit to be checked, tested and configured and firmware to be upgraded.

6.1 Opening the s2terminal and connecting to the unit

1. If a patient study is open close it so that the s2terminal can communicate with the unit.

2. Connect the PC in which the s2terminal is installed to the unit and switch the PC and unit on.

3. Open the **Command Prompt**. (**Start\Programs\ Accessories**).

4. In the Command prompt key in **cd**, space and then the path where the s2terminal application is installed (e.g. **c:\program files\s2terminal**).

```
cd c:\program files\s2terminal
```

   Press **ENTER**.

5. Key in **s2terminal**, space and then the **IP address** of the unit. (On the unit GUI touch the settings button then the i button to display the IP address).

```
s2terminal 10.208.6.101
```

   Press **ENTER** to open the s2terminal and make a connection to the unit.

The s2terminal version number will appear together with a list of main commands.

```
---- S2 Terminal Help ------------------------------------
 xh       help
 xi       receive image from the device
 xr       reserve device
 xq       quit
----------------------------------------------------------
```

Software and firmware version numbers will appear after the list of main commands.

6.2 Accessing the service commands - xh

The service commands allow the operation of the unit to be checked, tested and configured.
IMPORTANT NOTE:
The unit must be in the **service** state to access the service commands.

1. To determine the current state of the unit key in the state command **status r**.

```
 status r
```

Press **ENTER** and the current state of the unit will appear on the display, for example **INIT**.

```
 INIT
```

The other possible unit states are, **IDLE**, **SELECT**, **READY**, **TRANSFER** and **ERROR**.
A detailed description of the all the unit states is given in section **Description of the unit states**.

2. If the unit is in either the **IDLE** or **ERROR** state you can go directly to the **SERVICE** state by keying in the **service** command.

SERVICE

Press **ENTER** to enter the **SERVICE** state.

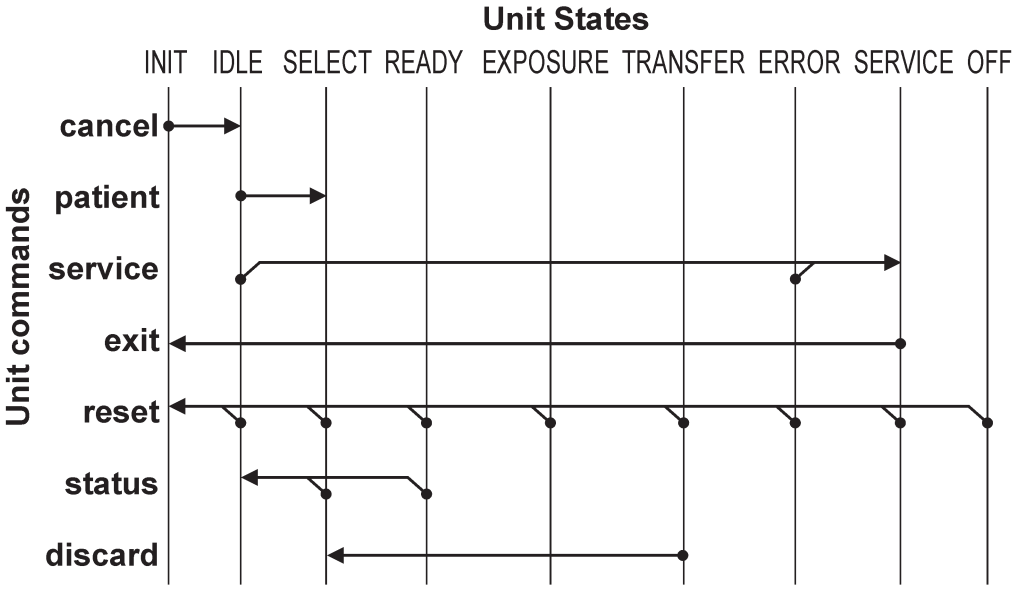
If the unit is in the **INIT** state:
go from **INIT** > **IDLE**, use **cancel** command,
then **IDLE** > **SERVICE**, use **service** command.

If the unit is in the **SELECT** state:
go from **SELECT** > **IDLE**, use **status** command,
then **IDLE** > **SERVICE**, use **service** command.

If the unit is in the **READY** state:
go from **READY** > **IDLE**, use **status** command,
then **IDLE** > **SERVICE**, use **service** command.

If the unit is in the **TRANSFER** state:
go from **TRANSFER** > **SELECT**, use **discard** command, then from **SELECT** > **IDLE**, **status** command and finally from **IDLE** > **SERVICE**, **service** command.

Unit commands to change unit states



CAUTION:
The **reset** command will change the state of the unit from any state to **INIT**.
Note, however, this command will delete any image in the unit CPU. If you wish to download the image use the **xi** command, described later, before using the reset command.

A detailed description of the unit commands is given in section **Description of unit commands**.

3. Key in **help** and then press ENTER.

```
help
```

A list of service commands will appear.

```
calclear     Clears completed calibrations flags
cancel       Bypasses initializations on startup.
clients      Displays connected client applications.
conf         Displays configuration parameters.
counter      Displays the number of exposures taken.
datatxdelay Sets packet delay on image transfer.
drivemotor   Drives the selected motor to desired position.
endstudy     If enabled, ends the patient study after cone beam exposure
help         Lists service commands/gives detailed help [command])
indicator    Sets or clears service/QA reminder messages or period.
ip           Configures the IP address of the external Ethernet interface.
log          Displays the log entries.
login        Displays unit's firmware version information
logsign      Adds a comment to the log
memtest      Performs a memory test on image memory area.
pantest      Grabs a panoramic image with test pattern.
patient      Starts fake study without using driver
status       Displays unit's status information.
systemstatus  Displays status of all optos, micro switches and encoders.
```

NOTE:
This list may vary from unit to unit.

4. To display help information for a service command key in **help**, space, the name of the service command and then press ENTER.
   For example **calclear**.

```
help calclear
```

Help instructions for that service command will appear.

```
help calclear

Clears completed calibration flags based on what parts of the unit
have been replaced, adjusted or other way serviced.
The unit's GUI will then show on the calibration program screen
which calibration programs need to be run again.
Usage: calclear [all|ccd|chair|collimator|frame|generator|
                 rotatingunit|panel|panel_psu|tubehead]
   all           : clear all flags
   ccd           : clears flags related to panoramic CCD camera
   chair         : clears flags related to chair and chin rest
   collimator    : clears flags related to collimator assembly
   frame         : clears flags related to unit's frame
   generator     : clears flags related to X-Ray generator
   rotatingunit : clears flags related to rotating unit
   panel         : clears flags related to (3D) flat panel
   panel_psu     : clears flags related to panel's power supply
   tubehead      : clears flags related to X-Ray tube head

Multiple items can be cleared by issuing the command multiple times.
```

The help information describes the different options for the service command selected.

5. To exit **SERVICE** key in **exit**, then **xq** and then press ENTER to close the s2terminal.

```
xq
```

Unlisted service commands

There are several other useful service commands the are not listed in the main help menu.
These are:

```
demomode    Sets the unit to the demonstration mode.

laserxl     Sets the usage of the lasers.

nomove      Toggles imaging movements on and off.

rotbelttest Tests rotating unit's belt.
```

Description of the unit states

INIT
The initialization has been partially completed. The unit is waiting for the chair down button to be pressed (a message requesting this will appear on the GUI).

IDLE
The unit is ready to start an examination and is waiting for image capture, from the dental imaging software, to be activated (a message requesting this will appear on the GUI).

SELECT
The imaging program and technique factors can be selected. When the RETURN key is pressed, to drive the rotating unit to the ready position, the unit will enter the next state, ready.

READY
The unit is ready to take an exposure. The text READY will appear on the GUI.

EXPOSURE
The unit will enter this state when the exposure switch is pressed and held down. The unit will enter the next state when the exposure button is released after the exposure is complete.

TRANSFER_CHECK
The image is being transferred from the unit to the PC. Note that image transfer already starts during exposure.

SERVICE
The only state from which the service commands can be accessed.

ERROR
The unit will enter this state if it malfunctions. An error message will appear on the unit GUI and the s2terminal if it is connected.

OFF
Indicates that firmware upgrades have been completed and the unit must be restarted for the upgrades to be activated.

Description of the unit commands

cancel
Changes the state of the unit from **init** to **idle** so that you do not have to press and hold down the chair down button during start up to complete the second part of the unit initialization.
NOTE:
If this command is selected immediately after the unit is switched on, the unit may enter the **error** state and not the **idle** state. This is because the chair and chin rest are not in their correct initialized positions (chair, lowest position and chinrest at the midpoint of its travel). Manually complete the initialization process (press and hold down the chair down key) whenever the unit is switched off and then on again to ensure that the unit will enter the **idle** state.

patient
Changes the state of the unit from **idle** to **select** so that you do not have to activate image capture to take an image.

service
Changes the state of the unit from **idle** or **error** to the **service** state so that the service commands can be accessed.

exit
Changes the state of the unit from **service** to **init**.

reset
Changes the state of the unit from any state to the **init** state. This command reboots the firmware (not core) on R3200 CPU.
CAUTION:
Any image in the CPU will be deleted.

status
Changes the state of the unit from **ready** or **select** to **idle**.

discard
Changes the state of the unit from **transfer** to **select**. This command ignores any image in the CPU (the image is NOT deleted). The image can be retrieved using the retrieve last image command (initiated using the GUI) or **xi** (described later).

clients
Shows how many client applications are connected to the unit, for example, the s2terminal and the dental imaging software and which of them has reserved thet unit.

login
Shows the firmware and core versions installed in the unit and the serial number of the unit.

6.3 Downloading raw images - xi

This command allows the **last image taken** by the unit to be downloaded from the unit memory in DCM (DICOM) format. This image can be used to check image quality.
NOTE:
If you wish to download **more than one** image in raw format refer to section **7.2 Saving raw images, projection images and log files**.

1. Disable (no image capture) or close the dental imaging program in the PC(s) connected to the unit to ensure that the s2terminal has reserved the unit.

2. In the main **s2terminal** folder create a subfolder and name it **imageseries**.
   NOTE:
   If you also create a **darkseries** subfolder dark images will be will be automatically stored there.

3. Key in **xr** and press the ENTER key so that the s2terminal reserves the unit.

```
xr
Mode RESERVED
```

The text **RESERVE** will appear which indicates that the s2terminal is now active and can communicate with the unit.

NOTE:
If you wish to take an test image release the s2terminal so that the unit is free to work normally.

Key in **xr** and then press ENTER.

```
xr
Mode NORMAL
```

The text **NORMAL** will appear which indicates that the s2terminal has been released.

Select the **patient** service command (Starts fake study without using driver),

```
patient
```

and take a test image.

After taking an image key in **xr** and then press ENTER.

```
xr
Mode RESERVE
```

The text **RESERVE** will appear which indicates that the s2terminal is now active again.

4. Key in **xi** and the press ENTER.

```
xi
```

The last image taken by the unit will be downloaded from the unit memory in the previously created subfolder .
Note that if the image is a panoramic it will be saved in the **s2terminal** folder and NOT the **imageseries** subfolder.

Image will be saved in DCM (DICOM) format. The saved image can be opened with the dental imaging software or image viewers such as **ImageJ** or **IrfanView**.

NOTE:
If the unit was switched off after the last image was taken the image will be lost.

5. Key in **xq** and then press ENTER.

```
xq
```

6.4 Updating firmware

Core updates - gui, r3200, 3310, 3400

1. Make sure that the unit is switched on and ready to take an exposure (refer to user's manual).

2. If an s2terminal folder has not already been created in the PC connected to the unit, create one.

3. Copy the update firmware (and s2terminal if has not been previously installed) into the new folder. The update names are:
   gui.pof
   r3200.pof
   r3300.pof
   r3400.pof
   cbctfw.srec (command xf)

4. Key in **xr** to reserve the unit.

---

xr
Mode RESERVE

---

5. Key in **xh** to open the firmware update commands.

---- S2 Terminal Help ----------
xh help
xi receive image from the device
xr reserve device
xq quit
--- Unit specific commands ----------
xcc <r3200:r3300:r3400:gui> core update
xf firmware update

---

6. Key in the device to be update, for example **xcc r3200**, and then press ENTER.

```
xcc r3200
```

IMPORTANT NOTE:
If you are updating the firmware in ALL the devices the updates MUST be carried out in the following order:
<xcc gui>
updates the GUI on the embedded PC (gui.pof).

<xcc r3400>
updates the FPGA core and the embedded software on R3400 (r3400.pof)

<xcc r3300>
updates FPGA core and the embedded software on R3310 (r3300.pof).

<xcc r3200>
updates the FPGA core and Boot SW on R3200, the main CPU (r3200.pof).

During the upload the transfer information will appear in the s2terminal window.

If you have problems with any of the updates DO NOT switch the unit off. Repeat the upgrade.

7. After you have completed the upgrade(s) wait for the unit to reboot itself and then restart the unit.
NOTE:
The upgrades will only come into effect after the unit has been restarted.

8. Use the **login** command to verify that the updating was successful. With the GUI update the new version number will appear on the unit display when the updated has been completed.

Updating the main firmware - xf

VERY IMPORTANT:
Updating the main firmware (xf) MUST be carried out when the unit is in the boot mode.
To enter the boot mode the task described next MUST be carried out within a certain time period.
READ THE FOLLOWING INSTRUCTIONS **BEFORE** STARTING THE TASK

1. Switch the unit on and wait until the following text appears.

```
CBCT R3200 boot 2.14.1929>
```

Type in the word **safe** (the letters will appear between the count down times) and then press ENTER. The text **Staying in boot mode** will appear.

```
CBCT R3200 boot 2.14.1929> . . . 6 . . 5sa . . . 4fe
Staying in boot mode
```

If you do not type the word **safe** quickly enough (before the count down time period ends) the unit will continue to start up and WILL NOT enter the boot mode. If this happens, restart the unit and try again.

WARNING:
Make absolutely sure that you are in the boot mode before proceeding. The text "Staying in the boot mode" confirms this. If the unit is NOT in the boot mode the following steps may corrupt the flash memory.

2. Key in **xh** to open the firmware update commands.

```
---- S2 Terminal Help -------------------------------------
 xh       help
 xi       receive image from the device
 xr       reserve device
 xq       quit
--- Unit specific commands -------------------------------
 xcc <r3200:r3300:r3400:gui> core update
 xf       firmware update
----------------------------------------------------------
```

3. Then key in **xf** and then press ENTER.

```
xf
```

NOTE:
If a message appears asking you to switch the unit off, **ignore** the message, press any key and then retype xf and press ENTER.

```
############################################################
#
# Unit must be restarted after core update ...
#
```

During the upload the transfer information will appear in the s2terminal window.

The **xf** command updates the main embedded software on R3200, the main CPU (cbctfw.srec).

The **xf** update will be activated immediately after it has been updated.

4. Use the login command to verify that the updating was successful.

7. Error Codes and Troubleshooting

7.1 Initial actions

Error Codes

When an error code appears on the display the unit will stop working and cannot be operated while the error code is on the display.

Restarting the unit

If an error code appears or the unit fails to operate in the way described in the user's manual, switch the unit off, wait for a few seconds and then switch the unit on again. If the error code reappears or unit still does not operate correctly, follow the troubleshooting procedures described here to identify and correct the problem.

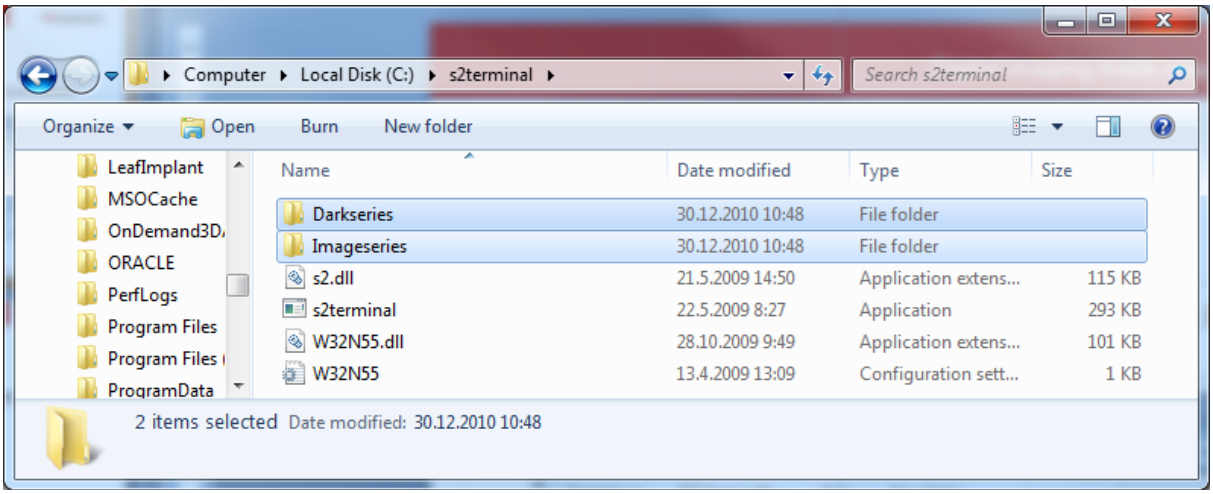
Image transfer

If an image is not transferred successfully to the PC, close and then reopen the dental imaging software and/or restart the PC.
DO NOT restart the unit as this will erase any image that is stored in the unit memory and this retrievable image will be lost.

7.2 Saving raw images, projection images and log files

Saving Raw files with s2terminal

1 Create Imageseries and Darkseries sub folders under s2terminal folder.



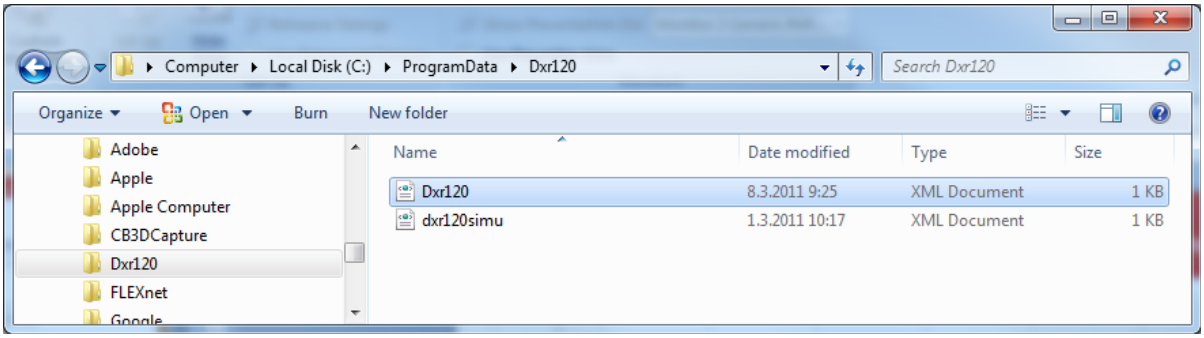
2. Open s2terminal and reserve the unit <xr>.
3. Type <patient>.
4. Take an image.
5. Type <xi> to receive the image.

CBCT raw images are located in Imageseries folder and dark images in Darkseries folder
Scout and panoramic image are located in s2terminal folder.

Saving Raw images

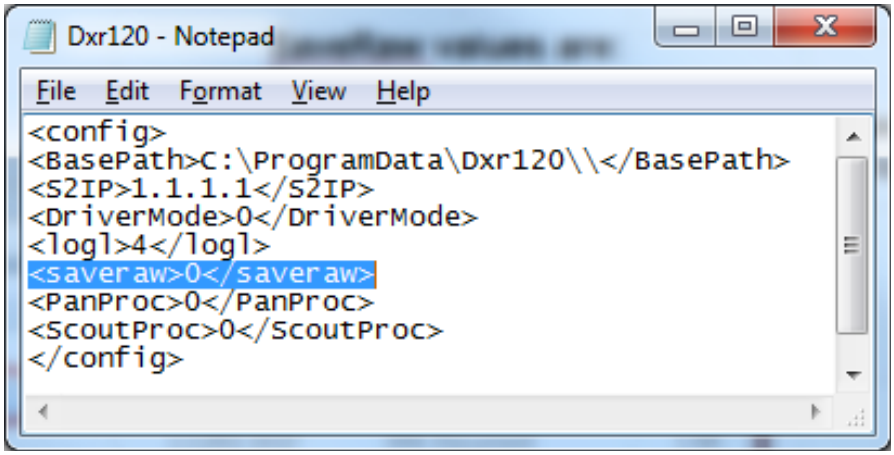
To create saveraw value

1. Browse to Dxr120 folder.



2. Open Dxr120 xml file with notepad.
3. Create or modify saveraw value.
4. Save the file.

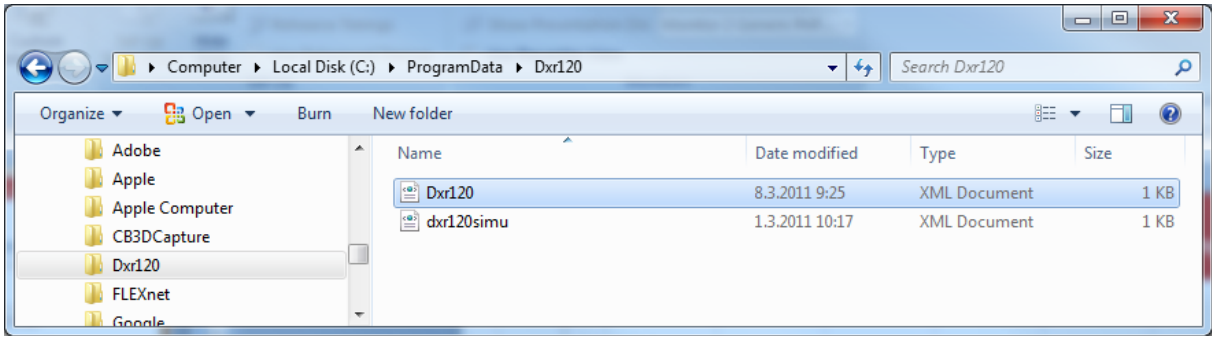
SaveRaw values are:
0: save no raw image
1: save the last image taken with each program
2: save every image (consumes a lot of disk space)



Saving Log files

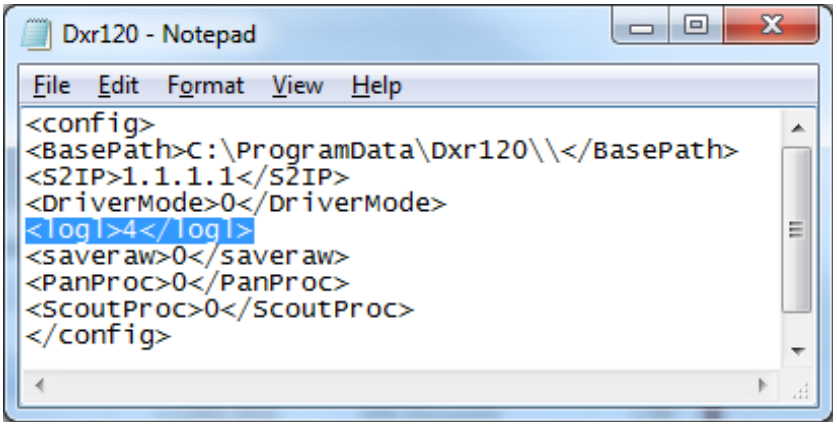
To create logl value

1. Browse to Dxr120 folder.



2. Open Dxr120 xml file with notepad.
3. Create or modify logl value.
4. Save the file.

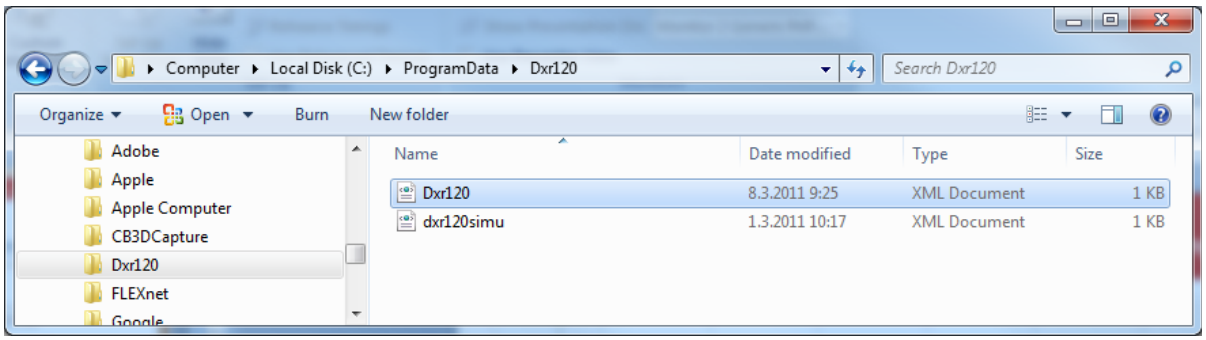
logl values are:
0: save no logs
1: save some
2: save all logs



Saving Projection images

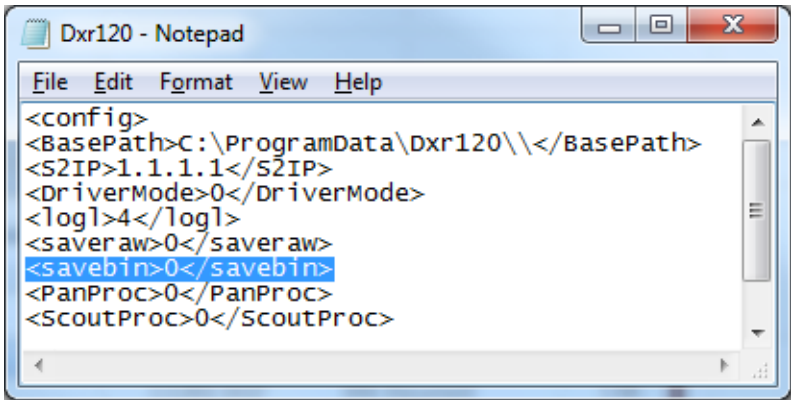
To create savebin value

1. Browse to Dxr120 folder.



2. Open Dxr120 xml file with notepad.
3. Create or modify savebin value.
4. Save the file.

savebin values are:
0: save no projection images
2: save projection images (consumes a lot of disk space)



Location of Log files and Raw & Projection images

File locations
Raw images are saved into the folder BasePath\Raw
Projection images are saved into the folder BasePath\Proj

The log files are saved into the BasePath folder, with extension .log

NOTE:
LogL value 4, SaveRaw value 2 and SaveBin value 2 will consume a lot of disk space and should be used only when trouble-shooting the system

7.3 Checking the unit

Diagnosing faults with the s2terminal

The s2terminal includes commands that allow the operation of the unit to be checked.
Unit service commands:

- **systemstatus**, allows the functionality of the optosensors, switches and micro switches to be checked.
- **drivemotor x** (x = the motor name), allows the operation of the different motors to be checked.
- **pantest**, takes a panoramic image of a text pattern. This will allow you to check if the pan (CCD) sensor is working.

s2terminal command:

- **Downloading raw image - xi**, downloads the last image taken by the unit.

Refer to section, **6. The s2terminal and service functions**.

Checking circuit boards

Circuit boards cannot be repaired in the field. Some boards have fuses that can be replaced. However, if a board is faulty, replace it.

On most of the circuit boards there are indicator LEDs (D) and test pins (TP), that allow the operation of the board to be checked and/or tested. The LEDs and test pins for each circuit board are described in the section **Electrical Description**.
Use a digital multimeter (DMM) when checking boards.

DANGER HIGH VOLTAGE:
R3400 IO2, R3710 X-ray power supply, R3810 X-ray generator and R3900 Mains connector include high voltage indicator lamps (Glim). When a high voltage lamp is on it indicates that high voltage is present. DO NOT touch the board until the high voltage has dissipated and the lamp has gone out.

CAUTION:
When handling circuit boards take all necessary precautions to prevent the build up of static electricity and possible static damage to the boards.

Checking cables and connectors

Visually check cables for mechanical damage, cuts, damaged insulation and bad twists. If a cable is damaged in any way replace it.

If there is no obvious mechanical damage to a cable but you think that it may be faulty, use a digital multimeter (DMM) to check the resistance of the different wires within the cable. An undamaged wire will have close to no resistance (>0 ohm), a damaged wire will have a high resistance value.

Make sure that all cables are correctly and securely attached to their respective connectors. Connectors must not be loose or misaligned. If the connector has a locking mechanism make sure that it is locked.

If you find a loose or misaligned connector, disconnect it and check for bent, broken or missing pins. If there is damage that can be easily repaired, for example straightening a bent pin, repair the damage and reconnect the connector. If the damage cannot be repaired replace the cable.
Note that if the connector on the corresponding board is also damaged, the board may also have to be replaced.

7.4 Error code descriptions

Error 100

Internal Communication bus error.

CAUSE A
GUI PC cannot communicate with R3200 CPU.
SOLUTION A

i. Check the Ethernet switch/router. If it is faulty replace it.

ii. Check R3200 CPU. Replace if faulty.

iii. Replace the internal LAN cable.

Error 101

Incorrect internal message format.

CAUSE A
GUI and CPU firmware not compatible.
SOLUTION A
Update the GUI firmware.

Error 200

Exposure button is pressed.

CAUSE A
Exposure button in stuck down, shorted or broken.
SOLUTION A
Check the exposure switch with a DMM, replace if faulty.

CAUSE B
R3900 Mains connector or R3310 IO1 (or R3400 IO2 in some models) is defective.
SOLUTION B

i. Check R3900 Mains connector. Replace if faulty.

ii. Check the cable between R3900 Mains connector and R3310 IO1 (or R3400 IO2 in some models). Replace if faulty.

iii. Check R3310 IO1(R3400 IO2). Replace if faulty.

iv. Replace the cable between R3310 IO1 (or R3400 IO2 in some models) and the exposure switch.

Error 201

Emergency stop button is pressed.

CAUSE A
The emergency stop button is activated. R3200 CPU detects that the emergency stop button has been pressed down.
SOLUTION A
Release emergency stop button.

CAUSE B
The emergency stop button is shorted.
SOLUTION B
Check the switch operation with DMM, replace if faulty.

CAUSE C
R3400 IO2 is defective
SOLUTION C
Check R3400 IO2, replace if faulty.

Error 202

Chin rest safety stops not working (encoder malfunction).
Unit can still be used but take great care when positioning patients.

CAUSE
J-Motor encode failed
SOLUTION

i. Check the wiring between the J-motor and R4800 Chin rest opto. Replace if faulty.

ii. Check R4800 Chin rest opto, replace if faulty.

iii. Replace the J-motor / patient support assembly. If you replace the patient support assembly you must carry out the Geometry Calibration (4). See ***9 Calibration and adjustment****.*

Error 1

Home position of rotating unit was not found.
(The PIO position)

CAUSE A
R3200 CPU does not receive the correct information from rotating position sensor N4100.
SOLUTION A
Check 1*:*
Switch unit off (30 seconds) and back on again and see if the rotating unit moves during initialization.
Check 2*:*
Use the s2terminal service program to check sensor and motor operation.

Rotating unit does not rotate

i. Check that R5100 3-phase stepper driver is receiving power, the D1 and D2 LED's must be on. If not check the low power schematic to locate the problem.

ii. Check the wiring between the R-motor and R5100 3-phase stepper driver. Replace if faulty.

iii. Check the wiring between R3200 CPU and R5100 3-phase stepper driver (J3204-J5101). Replace if faulty

iv. Check R5100 3-phase stepper driver, replace if faulty.

v. Check R3200 CPU, replace if faulty.

vi. Replace the R-motor (rotation).

Rotating unit rotates but cannot find its correct position

i. Check the wiring between R4100 Rotator opto and R3310 IO1. Replace if faulty.

ii. Check R4100 Rotator opto. Replace if faulty.

iii. Check rotation microswitch (system status s2terminal). Replace if faulty.

iv. Replace R3310 IO1 board.

CAUSE B
Belt(s) slipping.
SOLUTION B
Clean belt(s) and pulleys and adjust belt tension.

Error 2

Start position of rotating unit was not found.

CAUSE and ***SOLUTION***
Same as Error 1.

Error 3

Acceleration of rotating unit was too slow.

CAUSE A
Belt(s) slipping.
SOLUTION A
Clean belt(s) and pulleys and adjust belt tension.

CAUSE B
R3200 CPU does not receive the correct information from rotating position sensor N4100.
SOLUTION B

i. Check the wiring between R4100 Rotator opto and R3310 IO1. Replace if faulty.

ii. Check R4100 Rotator opto. Replace if faulty.

Error 4

The rotating unit optosensor was not found.

CAUSE and ***SOLUTION***
Same as Error 1.

Error 5

Exposure was taking too long and timeout occurred.

CAUSE
R3200 CPU has received back-up timer “active” signal from R3310 IO1.
SOLUTION

i. Check R3310 IO1. Replace if faulty

ii. Check cable between R3200 CPU and R3310 IO1. Replace if faulty.

iii. Replace R3200 CPU.

Error 6

X-Ray generator failed.

CAUSE
The generator protection circuit has been activated.
SOLUTION

i. Check R3810 X-ray generator. Replace if faulty.

ii. Check R3310 IO1. Replace if faulty.

iii. Check R3710 X-ray power supply. Replace if faulty.

iv. Check generator cabling. Replace if faulty.

v. Replace tubehead.

Error 7

Collimator motor failed.

CAUSE A
Collimator movement stopped by mechanical part(s).
SOLUTION A
Select different programs and take images in the test mode (no X-rays) and check collimator movement. Correct any mechanical problems.

CAUSE B
R3200 CPU does not get the correct information from R4200 Collimator opto.
SOLUTION B
Check 1*:*
Switch unit off (30 seconds) and back on again and see if the collimator moves during initialization.
Check 2*:*
Use the s2terminal service program to check sensor and motor operation.

Collimator does not move

i. Check that R5100 3-phase stepper driver, that drives the collimator, is receiving power, the +5V and +28V LED's must be on. If not check the low power schematic to locate the problem.

ii. Check the wiring between the C-motor and R5100 3-phase stepper driver. Replace if faulty.

iii. Check the wiring between R3310 IO1 and R5100 3-phase stepper driver (J3311-J5101). Replace if faulty

iv. Check R5100 3-phase stepper driver, replace if faulty.

v. Check R3310 IO1, replace if faulty.

vi. Replace the C-motor (Collimator).

Collimator moves but cannot find its correct position

i. Check the wiring between R4200 Collimator opto and R3310 IO1, (J4201-J3316). Replace if faulty.

ii. Check R4200 Collimator opto. Replace if faulty.

Iii. Replace R3310 IO1 board.

Error 8

Collimator slit motor failed.

CAUSE A
Slit movement stopped by mechanical part(s).
SOLUTION A
Select different programs and take images in the test mode (no X-rays) and check slit movement. Correct any mechanical problems.

CAUSE B
R3200 CPU does not get the correct information from R4200 Collimator opto.
SOLUTION B
Check 1*:*
Switch unit off (30 seconds) and back on again and see if the slit moves during initialization.
Check 2*:*
Use the s2terminal service program to check sensor and motor operation.

Slit does not move

i. Check the wiring between the S-motor and R3310 IO1. Replace if faulty.

ii. Check the wiring between R3200 CPU and R3310 IO1 (J3202-J3303). Replace if faulty

iii. Check R3310 IO1, replace if faulty.

iv. Check R3200 CPU, replace if faulty.

v. Replace the S-motor (Slit).

Collimator moves but cannot find its correct position

i. Check the wiring between R4200 Collimator opto and R3310 IO1, (J4201-J3316). Replace if faulty.

ii. Check R4200 Collimator opto. Replace if faulty.

Iii. Replace R3310 IO1 board.

Error 9

R3310 IO1 is not functioning.

CAUSE
R3200 CPU cannot communicate with R3310 IO1.
SOLUTION

i. Check the power LED on switch/router. If it is off, check R3100 Power supply and/or the cable between the R3100 Power supply and the switch/ router. Replace either or both if faulty.

If the power LED is on check the Ethernet switch/ router, replace if faulty.

ii. Check R3310 IO1, replace if faulty.

iii. Replace Internal Ethernet cable.

Error 12

R3400 IO2 card is not functioning.

CAUSE
R3200 CPU cannot communicate with R3400 IO2.
SOLUTION

i. Check the power LED on switch/router. If it is off, check R3100 Power supply and/or the cable between the R3100 Power supply and the switch/ router. Replace either or both if faulty.

If the power LED is on check the Ethernet switch/ router, replace if faulty.

ii. Check R3400 IO2, replace if faulty.

iii. Replace Internal Ethernet cable.

Error 13

Configuration data was lost.
CAUSE
R3200 CPU flash memory corrupted.
SOLUTION
Replace R3200 CPU and then recalibrate the unit.

Error 14

Home position of X-motor was not found.

CAUSE
R3200 CPU does not get correct information from N4600 Opto sensor.
SOLUTION
Check 1*:*
Switch unit off (30 seconds) and back on again and see if the rotating unit moves during initialization.
Check 2*:*
Use the s2terminal service program to check sensor and motor operation.

Rotating unit does not move

i. Check that R5100 3-phase stepper driver is receiving power, the +5V and +28V LED's must be on. If not check the low power schematic to locate the problem.

ii. Check the wiring between the X-motor and R5100 3-phase stepper driver. Replace if faulty.

iii. Check the wiring between R3310 IO1 and R5100 3-phase stepper driver (J3313-J5100). Replace if faulty

iv. Check R5100 3-phase stepper driver, replace if faulty.

v. Check R3310 IO1, replace if faulty.

vi. Replace the X-motor.

Rotating unit moves but cannot find its correct position

i. Check the wiring between N4600 Y-opto sensor and R5000 Extension Board (J4601-J5003). Replace if faulty.

ii. Check the wiring between R5000 Extension Board and R3310 IO1 (J5004-J3308). Replace if faulty.

iii. Check R4600 Opto sensor, replace if faulty.

iv. Check R5000 Extension Board, replace if faulty.

v. Replace R3310 IO1 board.

Error 15

Home position of Y-motor was not found.

CAUSE
R3200 CPU does not receive correct information from N4600 Y-optosensor.
SOLUTION
Check 1*:*
Switch unit off (30 seconds) and back on again and see if the rotating unit moves during initialization.
Check 2*:*
Use the s2terminal service program to check sensor and motor operation.

The seat does not move

i. Check the wiring between the Y-motor and R3400 IO2. Replace if faulty.

ii. Check the wiring between R3200 CPU and R3400 IO2 (J3203-J3402). Replace if faulty

iii. Check R3400 IO2, replace if faulty.

iv. Check R3200 CPU, replace if faulty.

v. Replace the Y-motor (chair).

The seat moves but cannot find its correct position

i. Check the wiring between N4600 Y-opto sensor and R3400 IO2 (J4601-J3406). Replace if faulty.

ii. Check R4600 Opto sensor, replace if faulty.

iii. Replace R3400 IO2 board.

Error 16

(NOTE: with GUI version 1.5 this error is 34)
CCD power failure.

CAUSE
R3200 CPU is not receiving data from the pan (CCD) detector.

SOLUTION A - power supply

*i. Check power LED's on the pan (CCD) detector during power up for the correct voltages (see section **Electrical description - Panoramic detector** for LED descriptions).*

ii. Check wiring between R3500 CCD power supply, the pan (CCD) sensor (J3502-X191) and L1400 EMC-filter board. Replace if faulty.

iii. Check the connection between L1400 EMC-filter board and R3500 CCD power supply.

SOLUTION B - data wiring

i. Check wiring between the pan (CCD) detector, L1400 EMC-filter board and R4910 Panorama interface (X190-J4901). Replace if faulty.

ii. Check the connection between L1400 EMC-filter board and R3500 CCD power supply.

iii. Check the wiring between the two R4910 Panorama interface boards (J4902 - J4902). Replace if faulty

iv. Check the connector between R4910 Panorama interface and R3200 CPU (J4904-J3208). Replace if faulty.

v. Check both of the R4910 Panorama interface boards. Replace if either or both are faulty.

vi. Check the R3200 CPU, replace if faulty.

vii. Replace the pan (CCD) detector.
If you replace the pan (CCD) detector you must carry out the following calibrations:
- 11. Collimator X panorama,
- 9. CCD X position,
- 12. CCD pixels,
- 14. CCD EPS,
*- Dose calibrations, 16 to 19 are optional. See **9 Calibration and adjustment**.*

Error 17

Configuration of CCD failed.

CAUSE
The data from the pan (CCD) sensor to R3200 CPU is corrupted or cannot be received.
SOLUTION

i. Check wiring between the pan (CCD) detector, R4910 Panorama interface (X190-J4901) and L1400 EMC-filter board. Replace if faulty.

ii. Check the connection between L1400 EMC-filter board and R3500 CCD power supply.

iii. Check the wiring between the two R4910 Panorama interface boards (J4902 - J4902). Replace if faulty

vi. Check the connector between R4910 Panorama interface and R3200 CPU (J4904-J3208). Replace if faulty.

v. Check both of the R4910 Panorama interface boards. Replace if either or both are faulty.

vi. Check the R3200 CPU, replace if faulty.

vii. Replace the pan (CCD) detector.
If you replace the pan (CCD) detector you must carry out the following calibrations:
- 11. Collimator X panorama,
- 9. CCD X position,
- 12. CCD pixels,
- 14. CCD EPS,
*- Dose calibrations, 16 to 19 are optional. See **9 Calibration and adjustment**.*

Error 18

Incorrect number of CCD scanned lines.

CAUSE
R3200 CPU is not receiving enough data from the pan (CCD) sensor
SOLUTION
*Same as **Error 17**.*

Error 19

DMA (Direct Memory Access) of the CCD failed.

CAUSE
R3200 CPU internal error
SOLUTION
*Same as **Error 17**.*

Error 20

CCD detector motor timeout.

CAUSE
R3200 CPU does not receive the correct information from R4200 Collimator opto and does not read the position microswitch status.
SOLUTION
***Check 1**:*
Use the s2terminal service program to check microswitch operation. If microswitch does not operate replace it.

Pan detector does not move

i. Use the s2terminal command “drivemotor” to check that R5100 3-phase stepper driver is receiving power, +5V and +28V LED’s are on. If not check the low power schematic to locate the problem.

ii Check wiring between D-motor and R5100 3-phase stepper driver. Replace if faulty.

iii Check wiring between R3310 IO1 and R5100 3-phase stepper driver (J3312-J5101). Replace if faulty.

iv Check the R5100 3-phase stepper driver, replace if faulty.

v Check R3310 IO1, replace if faulty.

vi Replace the D-motor.

Pan detector moves but cannot find the correct position

i. Check the belt tension.

ii. Check wiring between R4200 Detector opto and R3310 IO1 (J4201-J3302). Replace if faulty.

iii. Check R4200 Detector opto, replace if faulty.

iv. Replace R3310 IO1.

Error 21

Calibration data receive timeout.
(This error may occur during the QA (Quality assurance) procedure. Use the s2terminal to check for this error as it may not appear on the GUI).

CAUSE
The GUI PC does not send calibration data to R3200 CPU within the timeout period.
SOLUTION

i. Check the cables between the GUI PC and R3200 CPU. Replace if faulty.

*ii. The GUI PC not functioning. Replace. If you replace the GUI PC the unit must be completely recalibrated. See **9 Calibration and adjustment**.*

Error 22

DMA of 3D panel failed.

CAUSE

3D detector did not send picture data to *R3200 CPU*.

SOLUTION

i. Check cable between the 3D (CMOS) detector and R4400 Panel data adaptor. Replace if faulty.

ii. Check cable between R5310 Panel raw power supply and 3D power supply. Replace if faulty.

iii Check cable between R4710 3D panel power supply and 3D detector. Replace if faulty.

iv. Check cable between R4710 3D panel power supply and R3200 CPU, replace if faulty.

v. Check R3200 CPU, replace if faulty.

Check cable between R4400 Panel data adaptor and 3D detector. Replace if faulty.

vi. Replace the 3D detector. If you replace the pan (CCD) detector you must carry out the following calibrations:
3. CT Geometry,
6. Collimator Y CT,
7. Slit X,
8. Slit size,
9. Panel pix fast mode,
10. Panel pix fine mode,
12. CCD X,
15. CCD pix,
11. CT QC
Dose calibrations, 16 to 19 are optional. See ***9 Calibration and adjustment****.*

Error 23

Configuration data has corrupted.

CAUSE
The flash memory configuration data is missing or is corrupted.
SOLUTION
Replace R3200 CPU and calibrate the unit again.

Error 24

Voltage (kV) failure in R3810 X-ray generator.

CAUSE
The kV feedback from the generator to R3200 is not within the tolerance.
SOLUTION

i. Check the cable between R3310 IO1 and R3810 X-ray generator. Replace if faulty.

ii. Check R3310 IO1, replace if faulty.

iii. Check R3810 X-ray generator, replace if necessary.

Error 25

Current (mA) failure in R3810 X-ray generator.

CAUSE
The mA feedback from the generator to R3200 is not within the tolerance.
SOLUTION
*Same as **Error 24**.*

Error 26

Preheat failure in R3810 X-ray generator.

CAUSE
The preheat feedback signal from the generator to R3200 is not within the tolerance.
SOLUTION
*Same as **Error 24**.*

Error 27

Rotation encoder failed.

CAUSE
R3310 IO1 does not receive signals from R4100 Rotator opto.
SOLUTION

i. Check the wiring between R4100 Rotator opto and R3310 IO1. Replace if faulty.

ii. Check R4100 Rotator opto. Replace if faulty.

ii. Replace R3310 IO1 board.

Error 28

Chair encoder failed

CAUSE
R3400 IO2 is not receiving signals from the Z-motor encoder.
SOLUTION

i. Check the wiring between the Z-motor and R3400 IO2 (J4601-J3406). Replace if faulty.

ii. Check R3400 IO2, replace if faulty.

iii. Replace the Z-motor (lifting unit).

Error 29

Error in TDI pulsing.

CAUSE
Software corrupted.
SOLUTION
Update R3200 CPU firmware

Error 30

Firmware is corrupted.

CAUSE
The configuration flash memory is corrupted.
SOLUTION

i. Update R3200 CPU firmware.

ii. If error message reappears, replace R3200 CPU and then update the firmware if required.

Error 31

CPU memory test failed.

CAUSE
Memory module(s) faulty
SOLUTION

i. Replace memory modules on R3200 CPU.

ii. If error message reappears, replace R3200 CPU and then update the firmware if required.

Error 32

Z movement fail

CAUSE
R3400 IO2 is not receiving signals from the Z-motor encoder.
SOLUTION
*Same as **Error 28**.*

Error (no number)

CAUSE
Old GUI version.
SOLUTION
Update the GUI software.

Start up error

During boot up the GUI display freezes and only displays the GUI version, not the FW version.
When the Capture button in the imaging SW is pressed the following message appears:
Cannot start capture because there is no connection between the driver and thet Cone Beam 3D device.

CAUSE
Fuse F5 on R3100 blown.

7.5 Troubleshooting (refer also to 7.6 Troubleshooting diagrams)

1. Internal and external LANs

Problem 1.1 - No connection to the workstation (WS)

SOLUTION

- Check Ethernet connections from WS and/or local network.
  - o Reconnect the Ethernet cable to the WS (or local switch/router)
- Check condition of the External Ethernet cable.
  - o Replace whole cable track in upper shelf if cable is broken.
- Switch the unit off and connect the external 1GB Ethernet cable to the Service PC, open the s2terminal and switch the unit on again. Check that the login information appears in the s2terminal.
  - o If login info appears then the Ethernet Card in the WS is faulty or the software is corrupted or the network is misconfigured.
  - o If the login info does not appear, then open the outer cover from the sensor side of the rotator.
  - > Switch the unit on and check that R3200 is receiving power (see problem 3.7 R3200, R3310 or R3400 does not operate).
  - > Connect the service PC directly to J3210 on R3200 using separate Ethernet cable. Reboot the unit and check that login info appears in the s2terminal.

    >> If login info appears the external Ethernet cable is faulty. Replace the whole cable track in upper shelf.

    >> If login info does not appear then the R3200 is not programmed or faulty. Replace R3200.

Problem 1.2 - Connection to workstation breaks from time to time.

SOLUTION

- Check Ethernet connections from WS (and/or local network)
  - o Plug Ethernet cable back to the WS (or local switch/router)
- Check condition of the External Ethernet cable.
  - o Replace whole cable track in upper shelf if cable is faulty.
- Open the outer cover from the sensor side of the rotator and connect separate Ethernet cable from the WS to the J3210 on the R3200. Operate the unit normally, take some exposes, run the endurance test, etc.)
  - o If no problem exists then the external Ethernet cable is faulty. Replace the whole cable track in upper shelf.
  - o If the problem persists then either the network card in the WS or R3200 is faulty. First replace R3200 and operate the unit normally.
  - o If problem still persists after replacing R3200, replace Network card in the WS.

Problem 1.3 - No connection to R3310, R3400 or GUI PC (internal bus failure)

SOLUTION

- Switch the unit and check that R3310, R3400 and the Ethernet switch are receiving power (see problem 3.7 R3200, R300 or R3400 does not operate.)
- Check that the four activity LEDs on the Ethernet switch are flashing.
  - o If not then replace Ethernet switch.
- Check that ACT LED (D7) on R3200 is flashing.
- If not then bypass the cable track in upper shelf by using separate Ethernet cable between J3211, on R3200, and the Ethernet switch.
  - o If connection restarts then the Ethernet cable between R3200 and switch is faulty. Replace whole cable track in upper shelf.
  - o If connection does restart, replace R3200.

Problem 1.4 - No connection to R3310

SOLUTION

- Switch the unit on and check that R3310 and the Ethernet switch receive power (see problem 3.7 R3200, R300 or R3400 does not operate).
- Move the Ethernet cable from R3310 to another port in the Ethernet switch and reboot the unit.
  - o If connection restarts then the switch is broken. Replace it.
- Bypass cable track in upper shelf by using a separate Ethernet cable between R3310 and the Ethernet switch. Reboot the unit.
  - o If connection restarts then cable is faulty. Replace whole cable track in upper shelf.
  - o If connection does not restart replace R3310.

Problem 1.5 - No connections to R3400.

SOLUTION

- Same trouble shooting as Problem 1.4 - No connection to R3310.

Problem 1.6 - No connections to the GUI PC

SOLUTION

- Same trouble shooting as Problem 1.4 - No connection to R3310.

2. Power distribution (main)

Problem 2.1 - Nothing happens when the unit is switched ON.

SOLUTION

- Check that mains lead is plugged into the wall.
  - o If not plug it in.
- Check that mains is on.
  - o If not contact you local power supply company for help.
- Check Fuses F1 and F2.
  - o If blown replace them.
- Open electric cabinet and check that the lamp R3900 is on (or measure voltage at connector J3904)
  - o If there is voltage on R3900 measure secondary voltages from mains transformer. If any of voltages are missing replace the transformer.
  - o If there is no voltage follow mains power supply route from J3904 backward to the mains wall socket by measuring voltages at different connection points. Replace any component that are faulty.

Problem 2.2 - Chair does not move up or down.

SOLUTION

- Check fuse 1 on the R3400.
  - o If blown replace it.
- Check that lamp (LA1) on R3400 is glowing.
  - o If not then check that J2007 is connected.
  - > If connected then measure voltage at J2007.
    - >> If no voltage replace cable between J2007 and R3900.
    - >> If there is voltage replace cable between J2007 and J3411/J3412.
  - o If lamp is glowing replace R3400.
- If the R3400 has been replaced and chair still does not move, replace the chair lift unit.

Problem 2.3 - GUI PC not working.

SOLUTION

- Check that the mains cable is connected between R3900 and the GUI PC Power unit.
  - o If not, connect the cable.
- Check that there are low voltages (+5V and +12V) on the GUI PC power output (red wire +5V, yellow +12V)
  - o If there are no low voltages replace the GUI PC Power supply unit.
  - o If there are low voltages replace the GUI PC unit.

Problem 2.4 - No X-rays.

SOLUTION

- Check that lamp (LA1) on the R3710 (generator power) is glowing.
  - o If not then check that there are voltages on the input of the generator filter.
  - > If no voltages, replace the cable track in upper shelf.
  - > If there are voltages, replace the filter.
  - o If LA1 on R3710 is glowing check lamp (LA1) on R3810 (X-ray generator).
  - > If LA1 on R3810 is not on then check fuses on the R3710 and replace them if blown. If the fuses are ok then check cabling between J3703 and J3802
  - > If LA1 on R3810 is on then follow trouble shooting information in section 6 Exposure control.

3. Power distribution (low voltages)

Problem 3.1 - GUI starts but nothing else happens when unit switched on.
SOLUTION

- Check that all LEDs on R3100 are on.
  - o If not check the fuses on the R3100.
  - > If the fuses are blown, replace them.
  - > If fuses are OK replace R3100.
  - > If LEDs still don't come on then follow trouble shooting procedure for Problem 2.1 - Nothing happens when the unit is switched ON.
  - o If all the LEDs on R3100 are on, check that the +5V LED (D11) on R3200 is on.
  - > If not then check that the +5V LED on R5100 (detector swap stepper driver module) is on.

    >> If on, replace the cable between J4002 and J3206 (CPU power cable).

    >> If it is not on then replace the cable track in upper shelf.
  - > If LED (D11) is on, replace R3200.

Problem 3.2 - No X-, R-, Detector swap or collimator movement.
SOLUTION

- Check +5V and +28V LED's on the R5100 modules.
  - o If both LED's are on then refer to section 8. Motion control (general) for information on what to do.
  - o If +5V LED is off replace the cable between R5100 (J5101) and R3200 or R3300.
  - o If +28V LED is off check that +28V LED on R3100 is on.
  - > If off replace the fuse on the R3100. If still of after replacing the fuse and replace R3100.
  - > If on check +28V LED's on another R5100 module

    >> If LED is on there replace cable track in upper shelf.

    >> If LED is not on then check outgoing power cabling from R4000 and replace if necessary.
  - o If cabling is OK then replace R4000.

Problem 3.3 - Slit motor is not functioning.

SOLUTION

- Check that +28V LED on R5100 is on.
  - o If LED is on then follow trouble shooting instructions in section 8. Motion control (general) for information on what to do.
  - o If the LED is not on then follow the trouble shooting instructions in Problem: 3.2 No X-, R-, Detector swap or collimator movement.

Problem 3.4 - No Y-, J- movements.

SOLUTION

- Check that there is +28V on R3400 by measuring the voltage from J3404, pins 1 and 2.
  - o If the voltage is present then follow trouble shooting instructions in section 8. Motion control (general) for information on what to do.
  - o If the voltage is not present check that +28V LED on R3100 is on.
  - > If LED is not on check fuses.

    >> If fuses are OK, then replace R3100.
  - > If LED is on check cable between R3100 and R3400. Replace if faulty.

Problem 3.5 - The panorama imaging not functioning.

SOLUTION

- Switch the unit on, disconnect cable from J3503 on R3500 and check the LED's on R3500.
  - o If all LED's are on then measure voltages from the connector X191 on the CCD sensor.
  - > If the voltages are OK then replace CCD sensor.
  - > If some of the voltages is missing then replace the cable between X191 and J3502.
  - o If non of the LED's are on then measure voltages at J3501.
  - > If voltages are OK replace R3500.
  - > If voltages are not OK then follow the trouble shooting instructions in Problem: 3.2 No X-, R-, Detector swap or collimator movement.
  - o If some of the LED's are not on replace R3500.

Problem 3.6 - The 3D imaging is not functioning.

SOLUTION

- Launch the s2terminal, go to the service mode and select **test mode (no X-rays)** and **no move ON**. Type “autotest 1 c” into the s2terminal and check the LEDs D3 and D4 on the R4700.
  - o If both LEDs are on measure voltages at 3D sensor.
  - > If either one of voltages is missing then replace the cable between R4700 and sensor.
  - > If both voltages are present follow trouble shooting instructions for Problem 5.1 - 3D sensor is not recognized.
  - o If both LED’s are off measure voltage from J4701, pins 4 and 5.
  - > If voltage is present follow the trouble shooting instructions for Problem 5.1 - 3D sensor is not recognized.
  - > If voltage is missing check +8V LED (D27) on R3100.
    - >> If LED is OFF check fuses or replace R3100 as required.
    - >> If LED is ON replace cable track in upper shelf.
  - o If LED D4 (+5V_ana) is not on then measure voltage from J4701, pins 1 and 2.
  - > If voltage is present replace R4700.
  - > If voltage is not present check LED H2 on the R5310.
    - >> If LED H2 is on replace the cable track in upper shelf.
    - >> If LED H2 off check fuse F1 on the R5310.
      - >>> If blown replace it.
      - >>> If fuse is OK check that LED H1 is on.
        - I> If on, replace R5310.
        - I> If not replace mains transformer.

Problem 3.7 - R3200, R3300 or R3400 does not operate.

SOLUTION

- Switch the unit on and check the voltage indicator LEDs on the each board.
  - o If any of LED’s on a board are not on, replace the board.

4. Panoramic imaging

Problem 4.1 - CCD sensor is not recognized.

SOLUTION

- Check the condition of the power supply by following trouble shooting instructions Problem: 3.5 The panorama imaging not functioning.
- Bypass the installed LVDS data cable by using a separate cable and connect it between the two R4900 panorama interface boards (J4902 <-> J4902). Reboot the unit.
  - o If CCD sensor is recognized then replace original cable.
  - o If CCD sensor is not recognized then replace the R4900 attached to R3200 and reboot.
  - > If CCD sensor is recognized then the replaced R4900 was faulty.
  - > If CCD sensor is not recognized then replace R4900 assembled under the CCD sensor arm and reboot.
    - >> If CCD sensor is recognized then the replaced R4900 was faulty.
    - >> If CCD sensor is not recognized then replace CCD sensor.
      - >>> If new CCD sensor is recognized then the replaced sensor +was faulty.
      - >>> If new CCD sensor is not recognized replace R3200.

Problem 4.2 - Image is messy

SOLUTION

- Check condition of the power feed by following trouble shooting instruction Problem: 3.5 The panorama imaging not functioning.
- Use the s2terminal and select the service mode and then the test mode (no Xray). Type pantest, which will grab a test image from the camera. Open .dcm image (will be found same folder where s2terminal is located).
  - o If test image is OK then check calibration.
  - > If calibration is OK then replace CCD camera
  - > If not OK then calibrate Scanora 3D.
  - o If test image is poor then follow trouble shooting instruction Problem: 4.1 CCD sensor is not recognized.

Problem 4.3 - 3D-Image is too dark or light.

SOLUTION

- If the 3D-image is also dark then follow trouble shooting instructions in 6. Exposure control.

Problem 4.4 - Image is completely clear.

SOLUTION

- If the 3D-image is also fully light then follow trouble shooting instructions in 6. Exposure control.
- Check that slit-collimator is not closed.
  - o If it is closed then recalibrate the unit.
- Check that CCD sensor is positioned correctly.
  - o Check that sensor is not damaged mechanically. If it is correct or replace the damaged mechanical parts or replace the sensor.
  - o Check that rotating unit moves correctly and stops at right home positions by entering the service mode (s2terminal) typing the command drivemotor d with parameters c or p (c=CT position, p=PAN position).
  - > If motor does not move correctly follow trouble shooting instructions 8. Motion control (general)

5. 3D imaging

Problem 5.1 - 3D sensor is not recognized.

SOLUTION

- Check condition of the power feed by following trouble shooting instructions Problem: 3.6 The 3D imaging is not functioning.

- Replace the existing LVDS data cable that runs from J3208 to the 3D sensor and reboot the unit.
  - o If 3D sensor is detected then the originally cable was faulty.
  - o If 3D sensor not detected replace R3200 and reboot.
  - > If sensor is now detected, the original R3200 was faulty.
  - > If sensor is not detected then replace the sensor.

Problem 5.2 - Generally poor image.

SOLUTION

- Check condition of the power feed by following trouble shooting instructions Problem: 3.6 The 3D imaging is not functioning.
- Check unit calibrations.
- Follow instructions in instructions Problem 5.1 - 3D sensor is not recognized. Replace parts one by one and take a 3D image of the phantom until you identify the problem.

Problem 5.3 - Horizontal bars in projection image.
SOLUTION

- Check 3D sensor grounding cables.
  - o If OK then replace R4700.

Problem 5.4 - Gray scale reduced.
SOLUTION

- Follow instructions in Problem 5.1 - 3D sensor is not recognized. Replace components one by one and take 3D images using the QC phantom to check image quality.

Problem 5.5 - Shadows in the projection image.
SOLUTION

- Check that CCD sensor is parked to the CT-position
  - o If not then follow trouble shooting instruction Problem 4.4 - Image is completely clear , from the section "…CCD camera is positioned right".
- Check calibration
  - o If calibration OK then check that collimators are open as they should be.
  - > If not, follow trouble shooting guide instructions 8. Motion control (general)

6. Exposure control

Problem 6.1 - Exposure does not start when exposure switch is pressed.
SOLUTION

- Check condition of the power supply by following trouble shooting instructions Problem 3.7 - R3200, R3310 or R3400 does not operate.
- Set the unit to the standby mode, press exposure switch and check the status of the X-RAY ENA LED on R3310 (D502).
  - o If LED doesn't come on when exposure switch is pressed then remove connector J3306 and shortcut pins 1 and 2.
  - > If the LED does not come on replace R3310.

> If LED comes on replace J3306, remove J2002 from the vertical column and shortcut pins 7 and 14.

>> If the LED does not come on replace cable track in upper shelf.

>> If the LED comes on replace J2002 and remove J3905 from R3900 and short cut pins 1 and 2.

>>> If the LED does not come on replace the cable between J2002 and J3905

>>> If the LED comes on replace J3905 and remove J3907 from R3900 and short cut pins 1 and 2.

I> If the LED does not come on replace R3900

I> If the LED comes on replace external exposure switch.

o If LED D502 lights then set unit to imaging mode (CT or Pan), disable movements and check status of the PREH_ENA LED (D501)

> If doesn't come on after few seconds when exposure switch is pressed then replace R3310.

> If LED comes on then the exposure control is OK and beep sound should be heard. If not then replace R3310.

Problem 6.2 - Exposure sequence starts but no X-rays

SOLUTION

- Check condition of the power feed by following trouble shooting instruction Problem 3.7 - R3200, R3310 or R3400 does not operate.
- Set unit to imaging mode (CT or Pan), disable movements and the check status of the PREH_ENA LED (D501).
  - o If LED does not come on replace R3310.
  - o If LED comes on then check that X-RAY ENA LED (D500) comes on
  - > If X-RAY ENA LED come on then follow trouble shooting guide for X-ray generation.
  - > If does not come on measure the voltage during exposure from connector J3303 pin 5.

    >> If voltage goes above 2V replace R3310.

    >> If voltage is near 0V measure voltage from connector J3202 pin 7.

    >>> If voltage goes above 2V then check and if necessary replace cable between J3303 and J3202.

    >>> If voltage is near 0V then replace R3200.

7. X-Ray generation

Problem 7.1 - No X-rays.

SOLUTION

- Check condition of the power supply by following trouble shooting instructions for Problem 2.4 - No X-rays.
- Check the condition of the exposure control by following trouble shooting instructions for Problem 6.2 - Exposure sequence starts but no X-rays.
- Set the unit to imaging mode (CT or Pan), disable movements, press exposure switch and check the status of the Preheat LED (D3) on the R3810
  - o If it does not come on then check the condition of the cable between connectors J3314 and J3810.
  - > If cable is faulty replaced it.
  - > If cable is OK replace R3810.
  - o If LED comes on then check status of the exposure LED (D31) on the R3810
  - > If LED does not come on then check condition of the cable between connectors J3314 and J3810
    - >> If cable is faulty replace it.
    - >> If cable is OK check to see if the FAIL LED has come on.
      - >>> If not replace R3810.
      - >>> If FAIL LED still does not come on replace tubehead.

Problem 7.2 - Wrong dose generated (too dark or light images).

SOLUTION

- Check condition of the power feed by following trouble shooting instructions in Problem 2.4 - No X-rays.
- Check that the unit has been calibrated.

Preheat check

- Set the unit to the 3D imaging mode (type patient from s2terminal), adjust mA settings from GUI and measure respective voltages from TP11 on R3810 (Preheat reference).
  - o If voltages differ from below then replace R3310.
    - 8mA <-> 1.54V
    - 10mA <-> 1.59V
    - 12.5mA <-> 1.65V
    - 15mA <-> 1.70V
  - o If not then set mA settings to 15mA and measure voltage from TP15 (preheat feedback) when exposure is taken.
  - > If voltage is not 0.58V then replace R3810.
    - >> If it is still not 0.58V replace the tubehead.

mA check

- Set the unit to the 3D imaging mode (type patient from s2terminal), adjust mA settings from GUI and measure respective voltages from TP12 (mA reference).
  - o If voltages differ from below then replace R3310.
    8mA <-> 3.56V
    10mA <-> 3.19V
    12.5mA <-> 2.72V
    15mA <-> 2.26V
  - o If not then set mA settings to 15mA and measure the voltage from TP13 (mA feedback) when exposure switch is not pressed.
  - > if voltage is not 5.0V replace R3810.
  - > If voltage is close to 5.0V take an exposure and measure the voltage at TP13.
    >> If voltage is not about 4.3V then replace R3810.
    >>> If it is still not about 4.3V, replace the tubehead.
    >>> If voltage is around 4.3V then check the ribbon cable.
    I> If faulty, replace it.
    I> If cable is OK replace R3310.

kV check

- Select the following exposure parameters: standard resolution, 75 x 100 FOV, 15mA, 85kV and measure from voltage at TP8 (kV reference).
  - o If voltage is not 0.92 - 0.93V remove cable from J3807 and do take the same measurement from cable pin 5 (pin 16 is ground).
  - > If voltage is 0.92 - 0.93V replace R3810.
  - > If voltages is not 0.92 - 0.93V check the condition of the cable.
    >> If cable is faulty replace it.
    >> If cable is OK replace R3310.
  - o If voltage is 0.92 - 0.93V measure voltage from TP7 (kV feedback from tube)
  - > If voltage is not 1.25 - 1.26V replace R3810.
    If this does not solve the problem replace thet tubehead.
  - > If voltage is 1.25 - 1.26V measure voltage from TP13 (mA feedback)
    >> If voltage is not 0.58V replace R3810.
    >>> If this does not solve the problem replace the tubehead
    >>If voltage is 0.58V check condition of the ribbon cable
    >>> If cable is faulty replace it
    >>> If cable is OK replace R3310.

8. Motion control (general)

There are five main reasons for motion control malfunctions:

- Mechanical malfunction
- Power supply problem
- Actuator malfunction
- Sensor malfunction
- Control malfunction

Mechanical malfunctions are easy to correct because in most cases they are visible or audible. These malfunction are not described here.

In most cases it is recommended that you check the condition of power supplies first. The trouble shooting related the power distributions are described in sections 2. Power distribution (mains) and 3. Power distribution (low voltages). Basically checking the state of power indicators LED's will indicate the state of the power distribution.

Actuator malfunction can be caused by the motor or motor driver electronics. To trouble shoot use the s2terminal command **drivemotor** with suitable parameters (s2terminal lists the parameters). If there is no motion replace the different components, motor, electronics or cabling etc., one by one until the faulty component is located.

Sensor malfunctions can be solved in same way than actuator malfunctions. Setting the unit to service mode and using s2terminal command systemstatus, which will show status of all sensors (optos, micro switches, remote controller). Trouble shooting is easy. Manually move the assembly and at the same time follow the status changes of respective sensor. If the status does not change replacing sensor or related cabling will fix the problem.

If none of above solves the problem then faulty item is one of logic boards R3200, R3310 or R3400

No step-by-step trouble shooting guides for motion control (except for Z-motion), is included here because the motion problems are easy to solve with general guideline given above. However, the related block diagrams are included here to help you determine which components actuate which motion.

9. Z-motion control (chair)

Problem 9.1 - Chair does not move up or down.

SOLUTION

- Check the mains voltage distribution by following trouble shooting instruction for Problem 2.2 - Chair does not move up or down.
- Check low voltage distribution by following trouble shooting instruction for Problem 3.7 - R3200, R3310 or R3400 does not operate.
- Check condition of the remote control with the s2terminal command systemstatus
  - o If some of buttons do not change status then replace the remote control
  - > If that does not fix the problem then check cable from the electric cabinet to J3401. Replace if faulty.

    >> If that does not fix the problem replace R3400.
  - o If key statuses change then check that LED's D16, D18 and D15 (down, ena and up) come on when up or down keys are pressed.
  - > If LED's do not come on then replace R3400.
  - > If LED's come on then measure voltage from connector J3413. Pins 1 and 2 are active when driven UP and pins 3 and 2 are active when driven DOWN.

    >> If there is mains voltage at the connector replace chair lift.

    >> If there is no mains voltage replace R3400.

Problem 9.2 - Chair moves in one direction only.

SOLUTION

- Check low voltage distribution by following trouble shooting instruction for Problem 3.7 - R3200, R3310 or R3400 does not operate.
- Check that Z-limit indicator LED's (D30=lower limit and D31=upper limit), according to the drive direction, are not on.
  - o If a LED is on and the chair is not physically in the lower or upper limit position, then remove connector J3417 and measure resistance of the cable (pins 1 and 4 are for upper limit switch, pins 3 and 6 are for lower limit switch).
  - > If resistance is more than 1 Kohm then replace chair lift.
  - > If resistance is near 0 ohm then replace R3400.

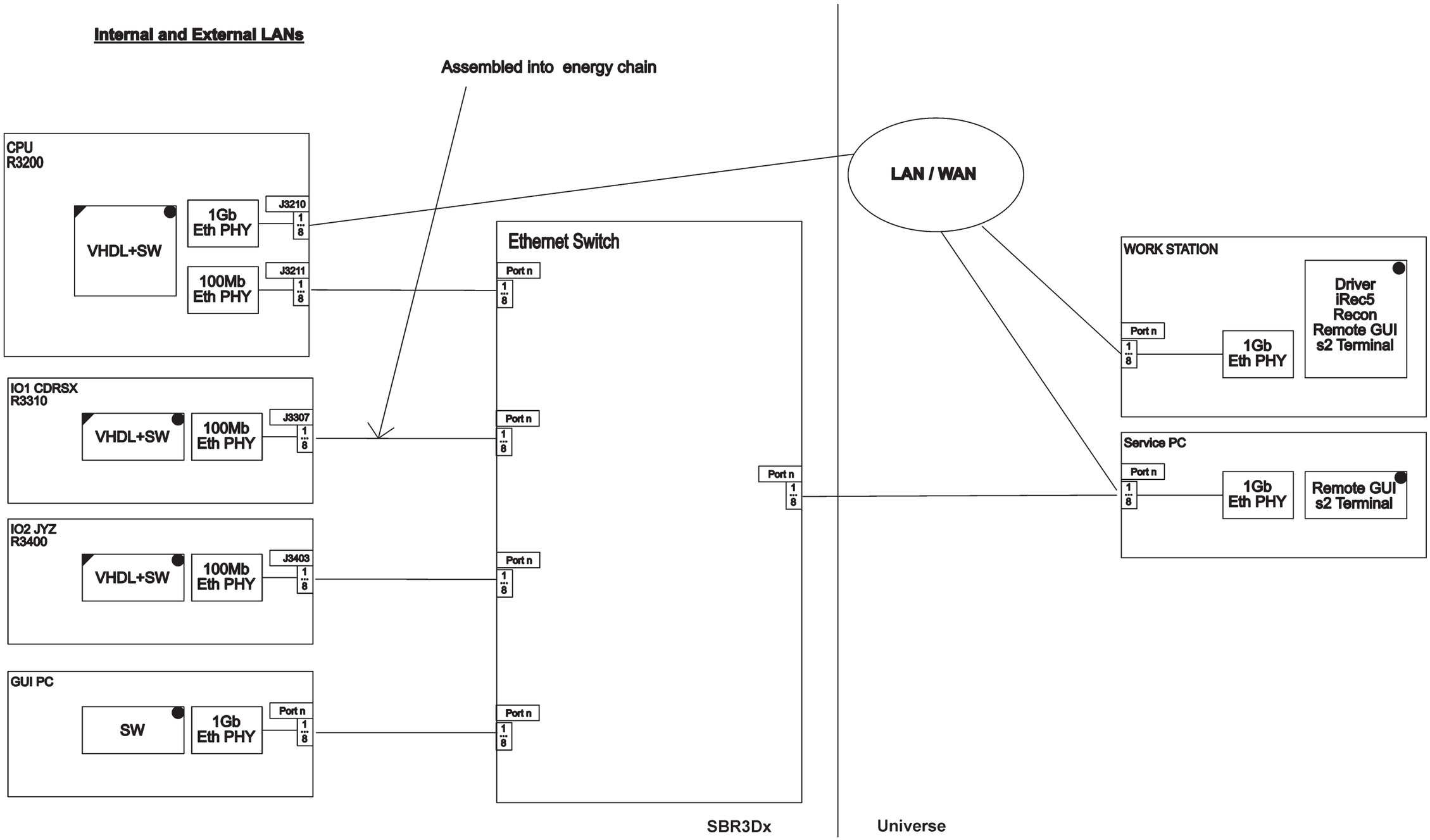
- o If LEDs are not on, then check that D16, D18 and D15 (down, ena and up) come on when chair up or down keys are pressed.
- > If they do not come on then replace R3400.
- > If they come on check if the Z-motor makes a “humming” noise when it is driven in malfunctioning direction.

  >> If it is make a “humming” noise replace R3400.

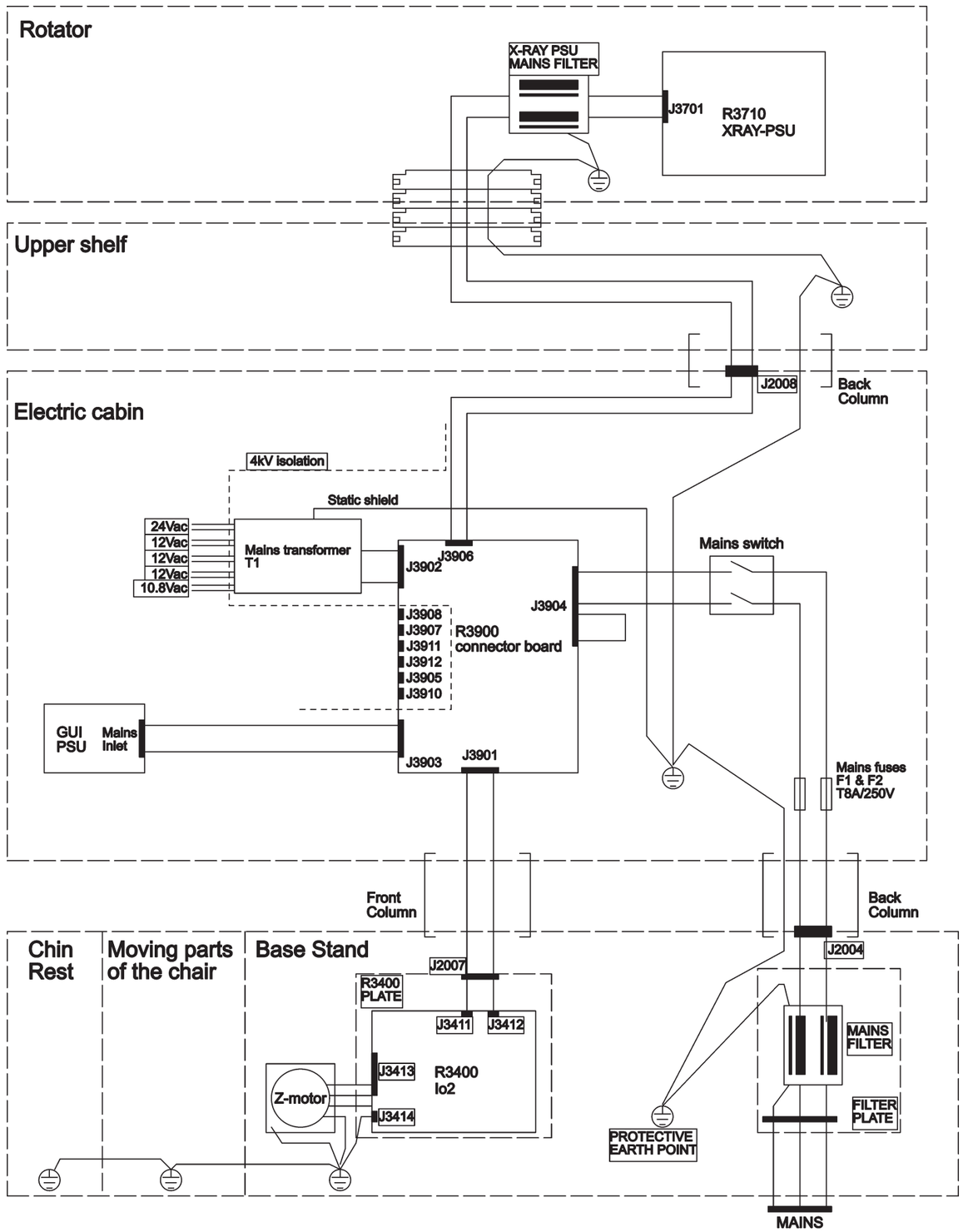
  >> If not replace lift motor.

7.6 Troubleshooting diagrams

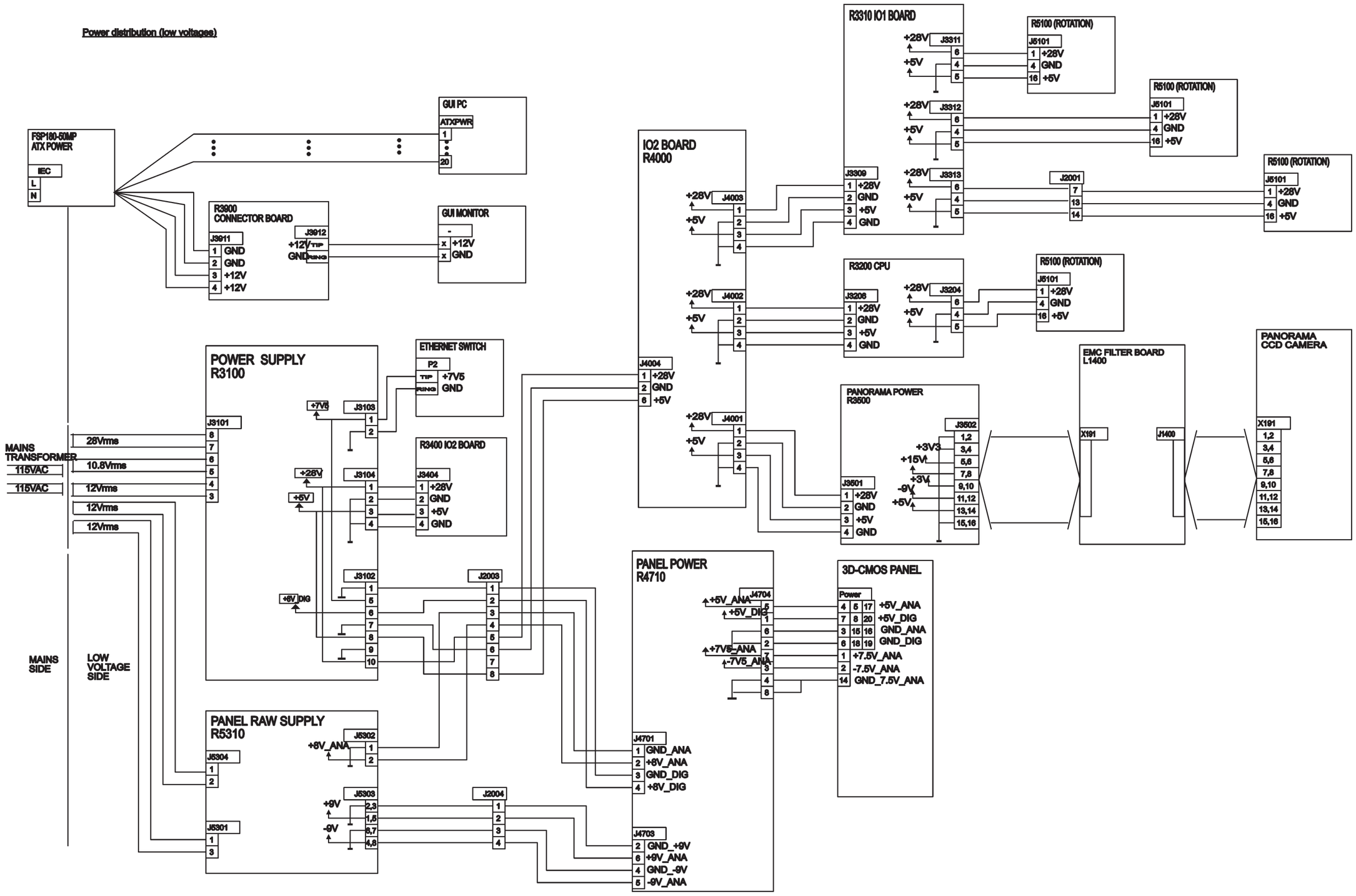
1. Internal and external LANs



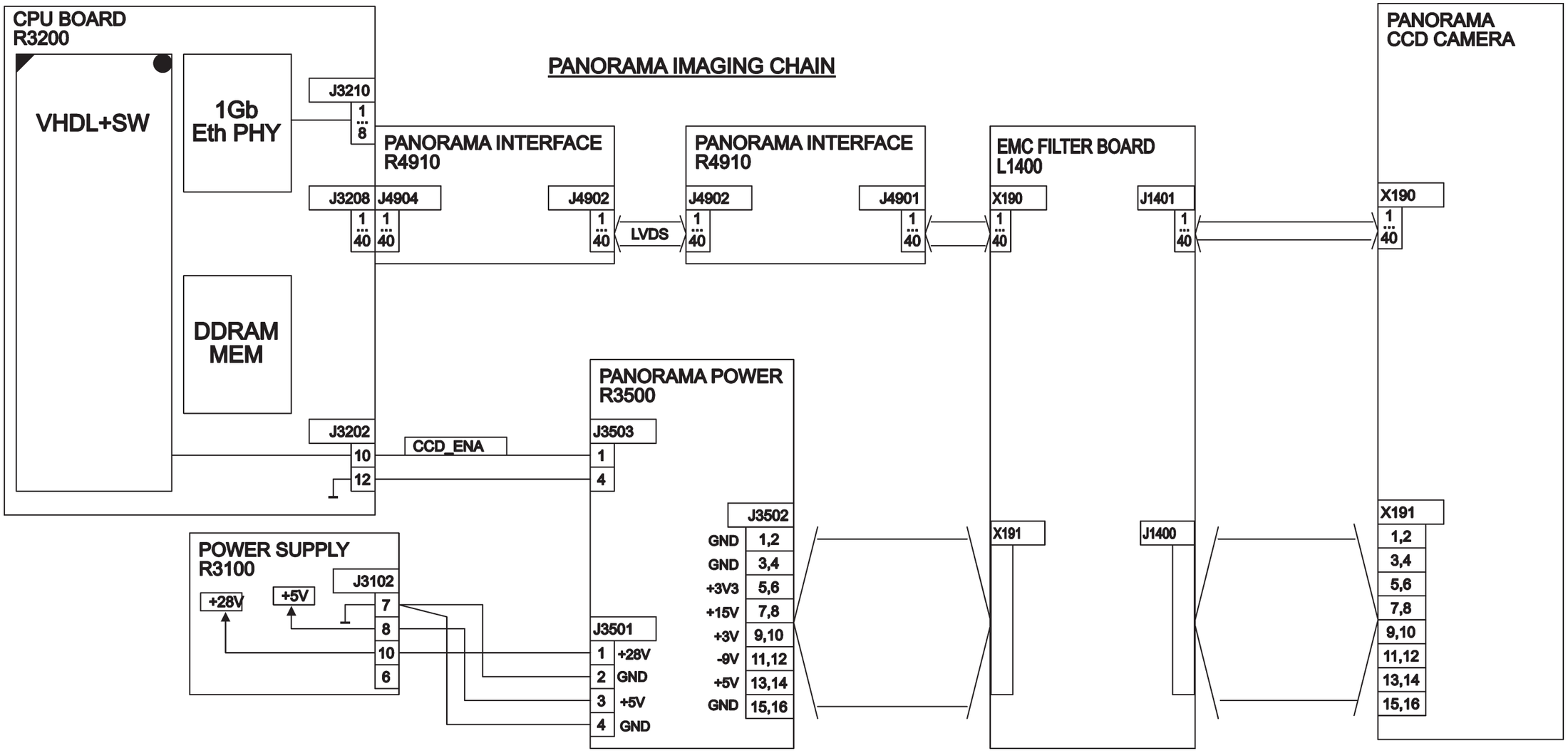
2. Power distribution (main)



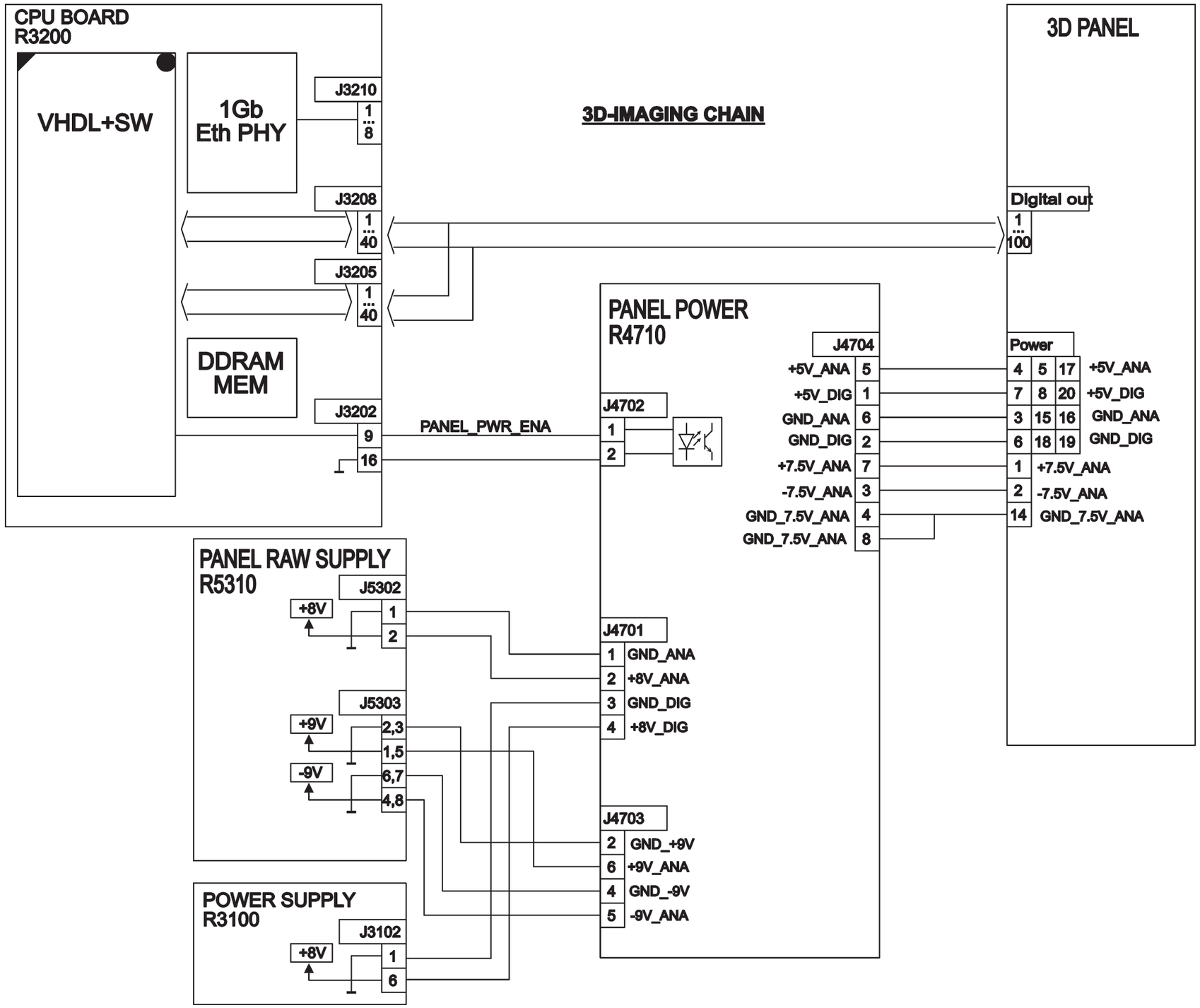
3. Power distribution (low voltages)



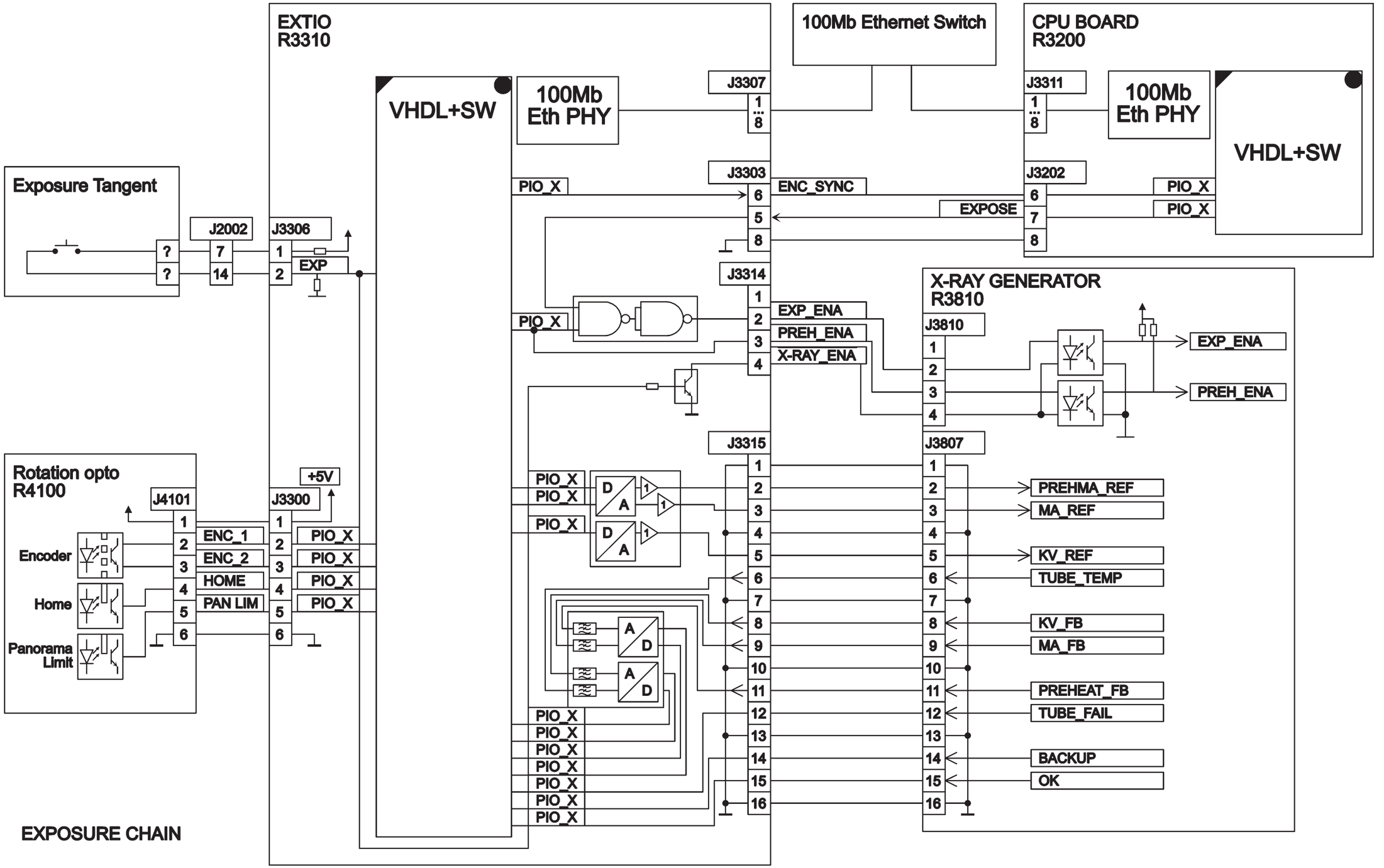
4. Panoramic imaging



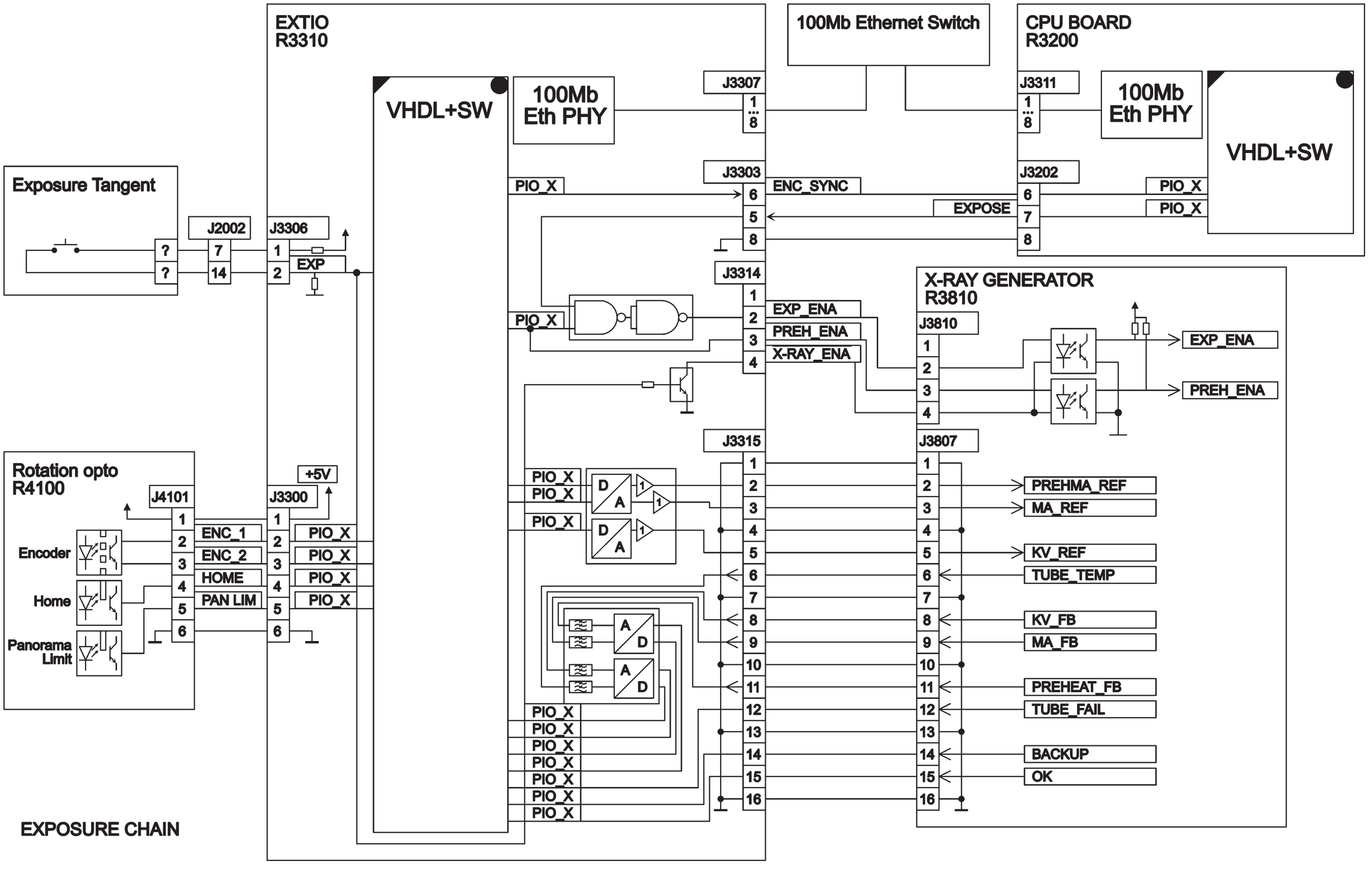
5. 3D imaging


CPU BOARD
R3200
VHDL+SW
1Gb
Eth PHY
DDRAM
MEM
J3210
1
...
8
J3208
1
...
40
J3205
1
...
40
J3202
9
16
3D-IMAGING CHAIN
3D PANEL
Digital out
1
...
100
PANEL_PWR_ENA
PANEL POWER
R4710
J4702
1
2
J4704
+5V_ANA 5
+5V_DIG 1
GND_ANA 6
GND_DIG 2
+7.5V_ANA 7
-7.5V_ANA 3
GND_7.5V_ANA 4
GND_7.5V_ANA 8
Power
4 5 17 +5V_ANA
7 8 20 +5V_DIG
3 15 16 GND_ANA
6 18 19 GND_DIG
1 +7.5V_ANA
2 -7.5V_ANA
14 GND_7.5V_ANA
PANEL RAW SUPPLY
R5310
J5302
+8V
1
2
J5303
+9V
2,3
1,5
-9V
6,7
4,8
POWER SUPPLY
R3100
J3102
+8V
1
6
J4701
1 GND_ANA
2 +8V_ANA
3 GND_DIG
4 +8V_DIG
J4703
2 GND_+9V
6 +9V_ANA
4 GND_-9V
5 -9V_ANA

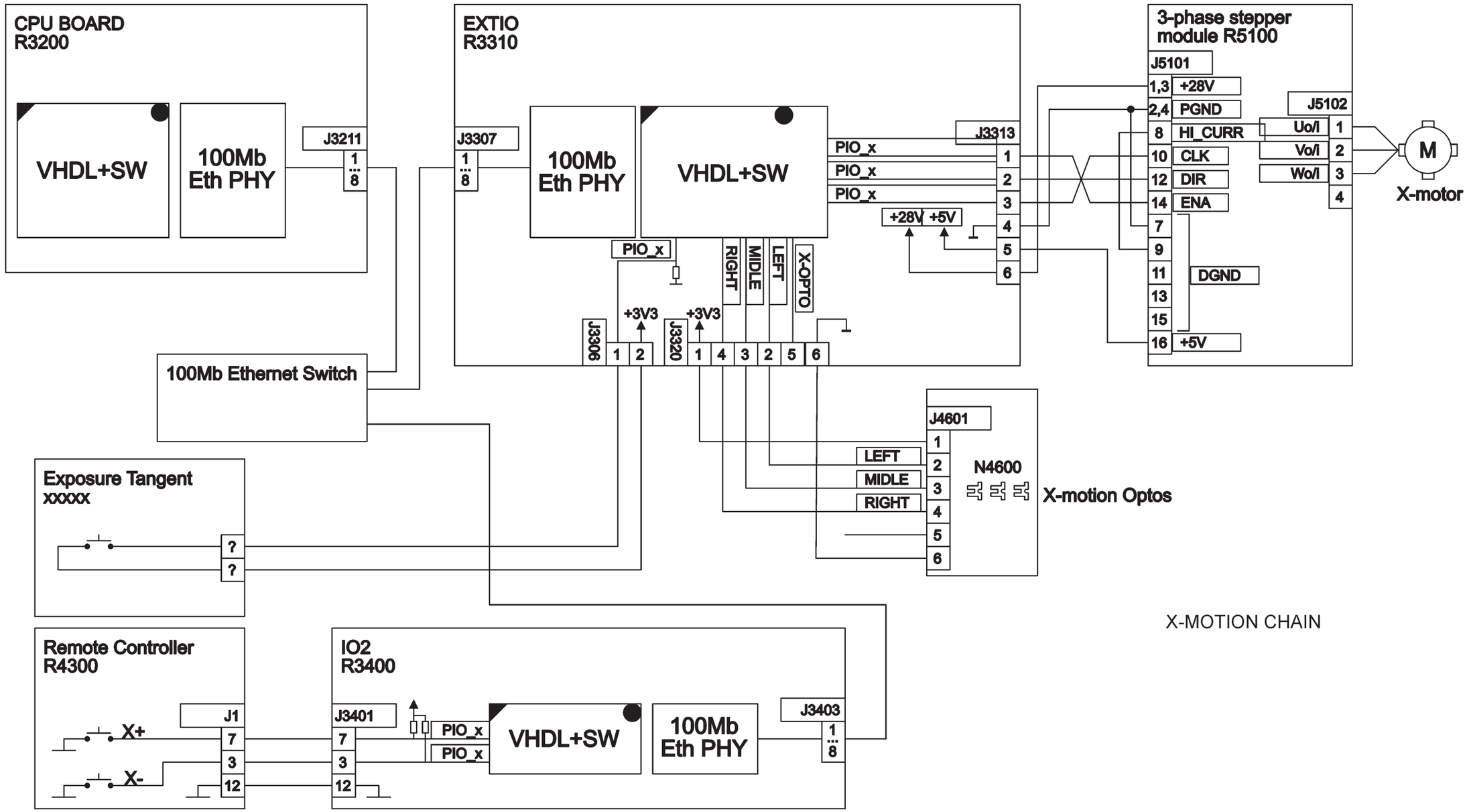
6. Exposure control



7. X-ray generation

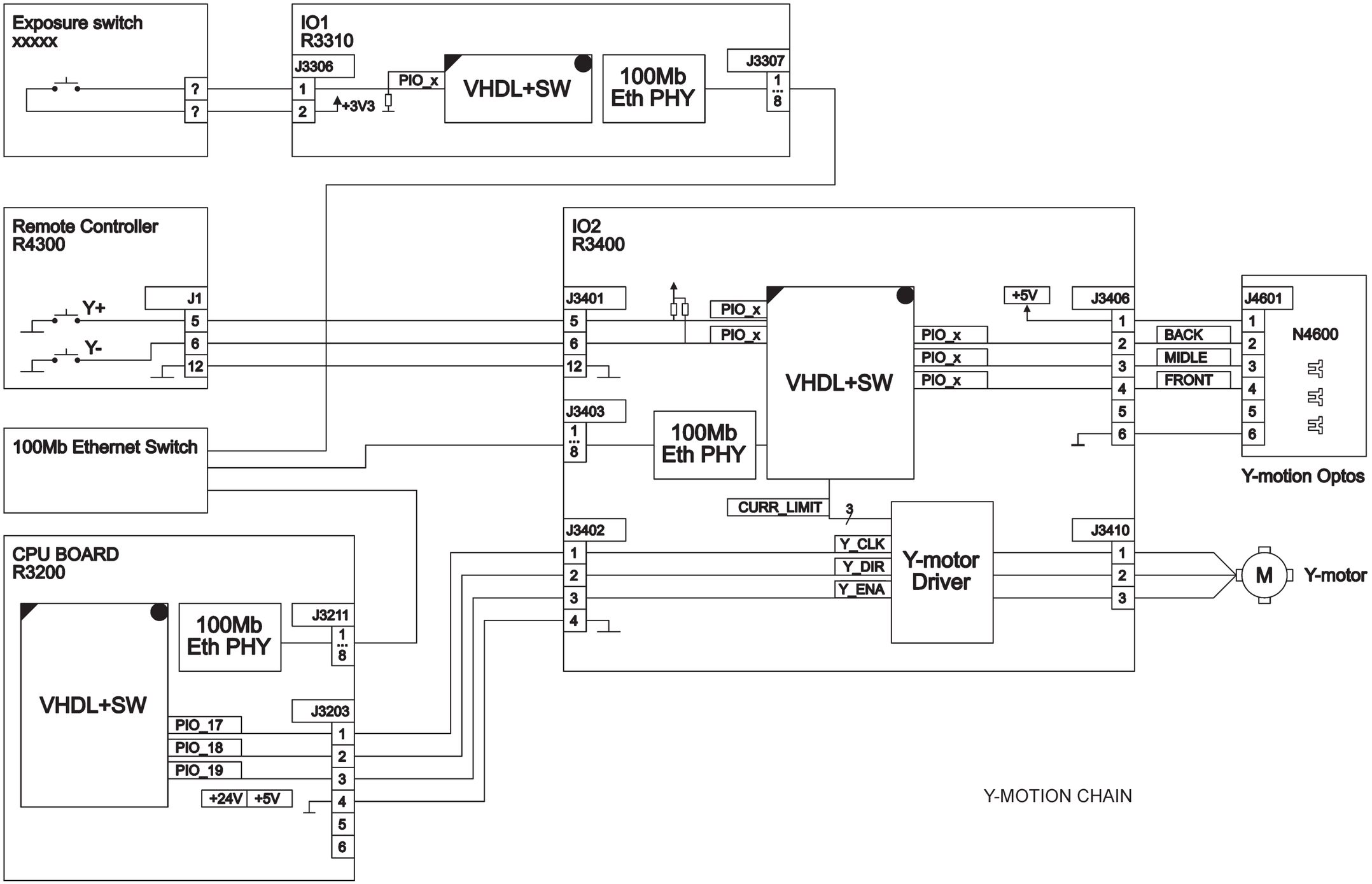


8. Motion control (X-movement)



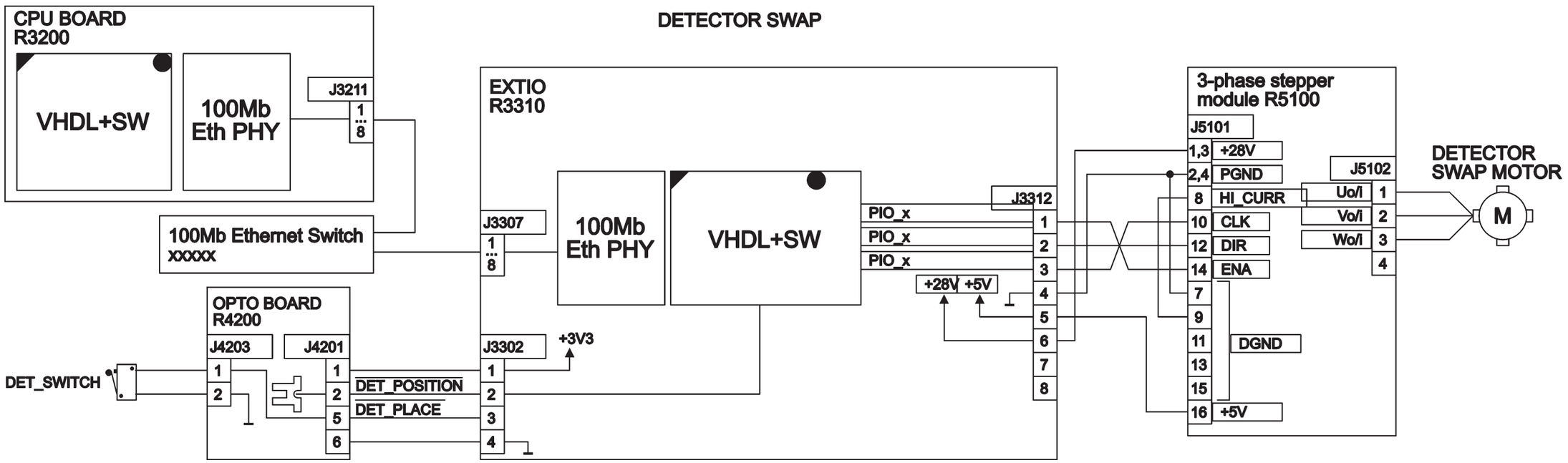
X-MOTION CHAIN

Motion control (Y-movement)

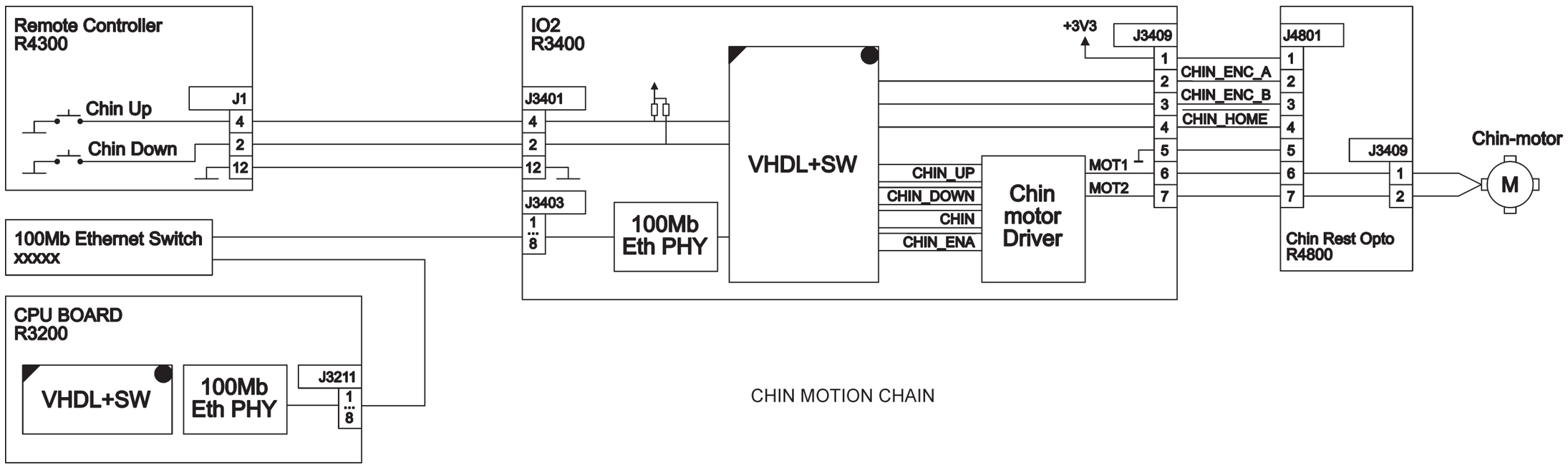


Y-MOTION CHAIN

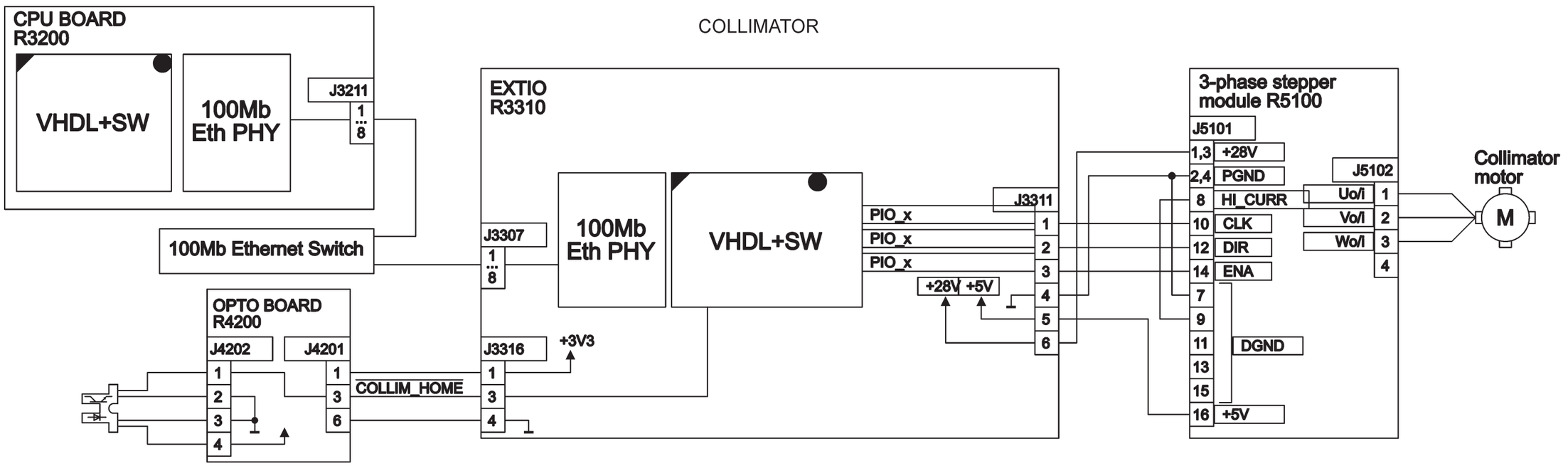
Motion control (D-movement, detector)



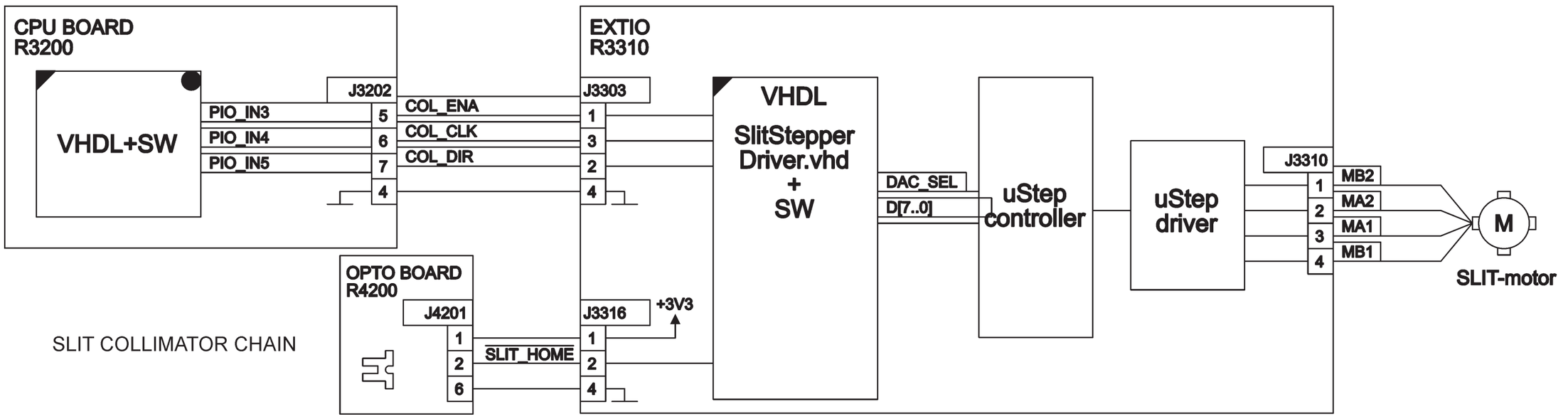
Motion control (J-movement, chin rest)



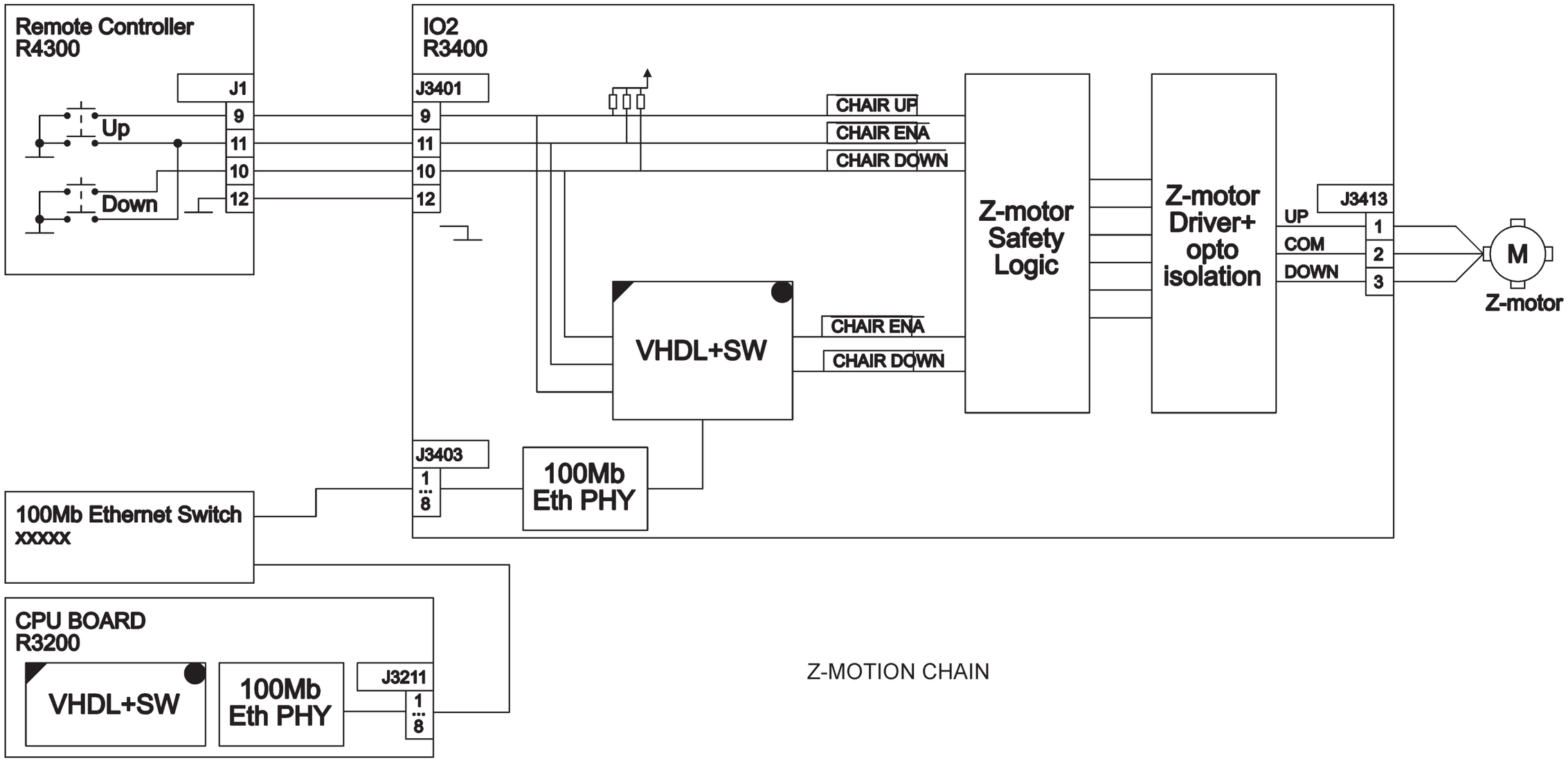
Motion control (C-movement, collimator)



Motion control (S-movement, slit)



9. Z-motion control (chair)



Z-MOTION CHAIN

8. Unit calibration and adjustment

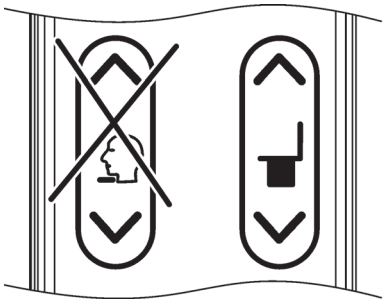
8.1 Introduction

The unit calibration procedure helps to maintain the image quality and maintain the correct operation of the unit.

When carrying out the full or partial unit calibration procedure the calibration and check steps must be carried out in the order in which they are listed.

If a calibration step fails repeat the calibration step a second time to see if it passes. If it fails again the unit must be manually adjusted.
Adjust the unit and recheck the calibration until the unit passes the calibration.
After this, repeat the remaining calibration steps.

During the unit calibration procedure calibration data is produced. This data will appear on the GUI. Also, 2D calibration and preview images are produced. These images will appear on the GUI and should be saved in the dental imaging program.



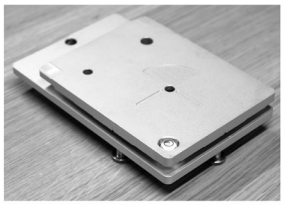
IMPORTANT NOTE:
ONLY use the Seat Height adjusting keys on the remote control to adjust the height of the QC and 3D phantoms. DO NOT use the head support height adjusting keys.

8.2 Alignment a Quality Assurance tools

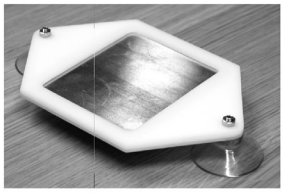
Geometry phantom

Quality assurance phantom =

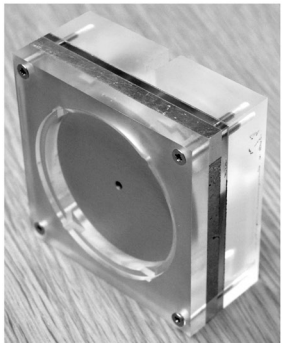
Ball and pin phantom (panoramic)



Levelling base

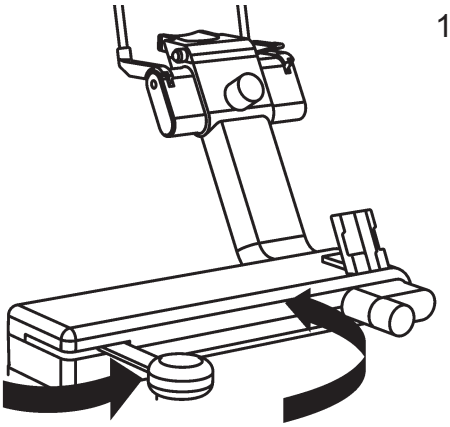


Copper filter

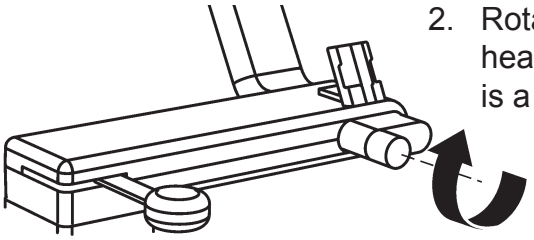


Test tool (line-pair phantom)

8.3 Preparing for calibration



1. Close the head support (rotate it towards the chair) and lock it in position with the head support locking lever.



2. Rotate the head support adjusting knob until the head support is in the **mid point** of its travel. There is a slight “resistance” when you reach this point.

3. Switch the PC and unit on (if the unit is on, restart it). A message will appear on the unit control panel asking you to press and hold the chair down button to complete unit start up.
   CAUTION: Crushing Danger!
   Before pressing the chair down button remove all objects, for example drawers, wheelchairs, stools etc., from around the chair to avoid damage to the unit or injury to people.

4. Press and hold the chair down key until the unit stops moving. A message will then appear asking you to select a patient and then start image capture.

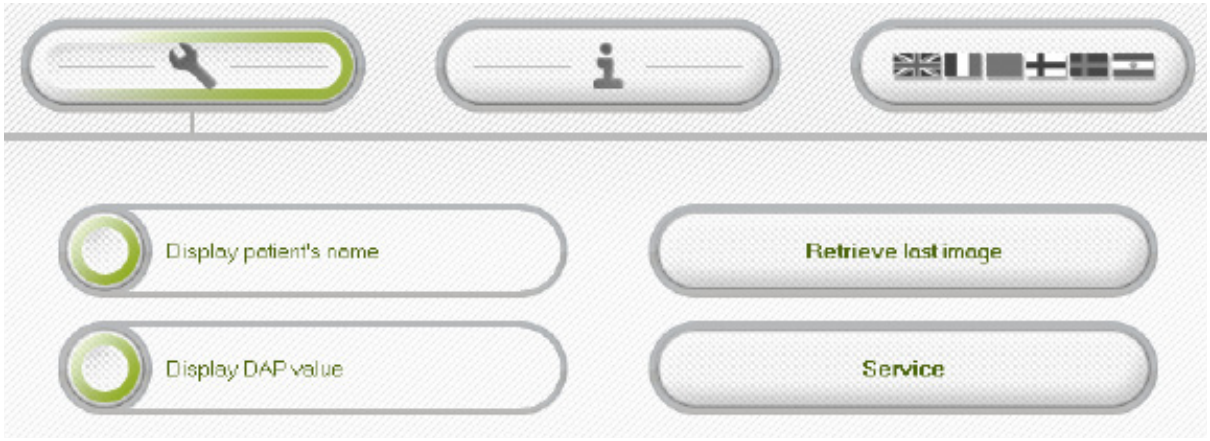
5. **PC:** Open the s2terminal and make sure that the unit is in the normal state. (refer to the section s2terminal for more information).

6. **PC:** Open the dental imaging software and then open a new patient (card) where you can store the calibration images, name it, for example, **calibration**. Refer to the user's manual supplied with the dental imaging software for information on opening patient cards.

7. **PC:** Click the image capture. The image capture window will open.

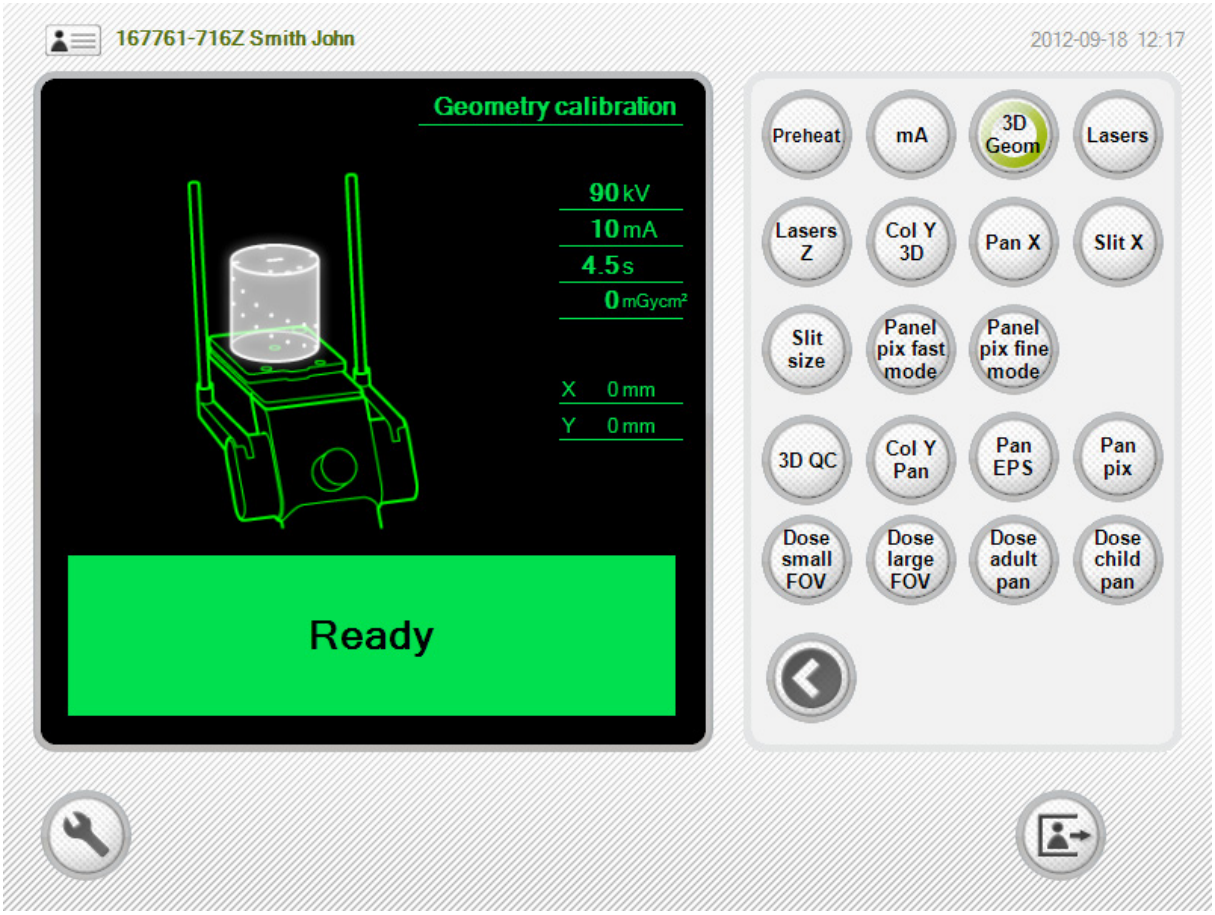
8. Touch the settings button on the unit display.

   The settings page will appear.



9. Touch Service button.

The calibration display will appear.



NOTE:
When a calibration button text is black, it indicates the calibration has not been carried out or has not been successfully carried out.
When the text is grey it indicates that the calibration has been carried out.

8.4 The calibration sequence

1. Preheat, tubehead calibration.
   Calibrates the tubehead preheat.

2. mA (Current), tubehead calibration.
   Calibrates the tubehead current.

3. 3D Geometry.
   Calibrates the rotation geometry of the rotating unit.

4. Lasers (X).
   Checks the position of the X-laser.

5. Lasers Z (Horizontal and vertical FOV).
   Checks the position of the Z and Y-lasers.

6. Collimator Y position, 3D.
   Calibrates the position of the 3D collimator in vertical direction.

7. Panoramic X position.
   Checks the horizontal position and tilt of the panoramic sensor. (Panoramic version only).

8. Slit X position.
   Checks the collimator slit in the horizontal direction.

9. Slit size.
   Calibrates the slit opening size for the 3D FOVs.

10. Panel pixels, fast mode.
    Calibrates the pixels, sensor gain and dark current, for the large 3D FOVs.

11. Panel pixels, fine mode.
    Calibrates the pixels, sensor gain and dark current, for the small 3D FOVs.

12. 3D quality check.
    Checks that the unit is able to read the different densities correctly. The positions of the laser lights can also be checked.

13. Collimator Y position, Panoramic.
    Calibrates the position of the panoramic collimator in vertical direction. (Panoramic version only)

14. Panoramic EPS.
    Calibrates the horizontal position of the panoramic sensor. (Panoramic version only).

15. Panoramic pixels.
    Calibrates the panoramic sensor gain and dark current. (Panoramic version only).

Optional dose calibrations

The nominal DAP (Dose Area Product) value (factory setting) is sufficient for normal use. However, if you want a more accurate value measure the DAP value using a DAP meter and then use this value instead.

16. Dose small FOV.
    Allows the DAP value for the small 3D program to be selected.

17. Dose large FOV.
    Allows the DAP value for the large 3D program to be selected.

18. Dose adult panorama.
    Allows the DAP value for the adult pan program to be selected. (Panoramic version only).

19. Dose child panorama.
    Allows the DAP value for the child pan program to be selected. (Panoramic version only).

8.5 When to calibrate the unit

The unit must be calibrated and, if necessary, adjusted at regular intervals in accordance with national regulations regarding the use, maintenance and service of dental x-ray devices that are in force in the country in which the unit is installed.
In any event, the unit must be completely recalibrated at least once a year. Dose calibrations, 16 to 19 are optional.

The unit must also be fully or partially calibrated when parts are replaced.
The calibration steps for the following replaced parts are as follows:

	THA	Rot Unit	R3200	GUI PC	3D panel	Pan panel	Colli-mator	Lift	R3810	R3310
1. Preheat	x	x	x	x					x	x
2. mA	x	x	x	x					x	x
3. 3D Geom	x	x	x	x	x			x		
4. Lasers	x	x	x	x						
5. Lasers Z	x	x	x	x						
6. Col Y 3D	x	x	x	x	x		x			
7. CCD X	x	x	x	x		x	x			
8. Slit X	x	x	x	x			x			
9. Slit size	x	x	x	x	x		x			
10. Panel pix fast	x	x	x	x	x	x	x			
11. Panel pix fine	x	x	x	x	x	x	x			
12. 3D QC	x	x	x	x	x	x	x		x	x
13. Col Y Pan	x	x	x	x		x	x			
14. Pan EPS	x	x	x	x			x			
15. Pan pix	x	x	x	x	x	x	x			

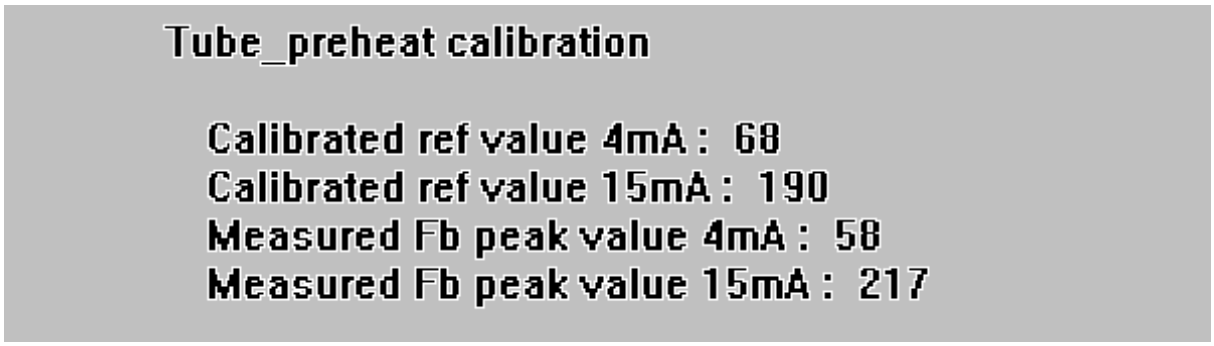
8.6 The Calibration and adjustment procedure

1. Tube calibration - Preheat

Calibrates the tubehead preheat.
Prerequisites: None.

1. Select Preheat.

2. **Protect yourself from radiation**.
   Press and hold down exposure button. The calibration can take about ten minutes to complete and x-ray generation starts and stops several times. Note that you MUST hold the exposure button down until the calibration is completed.
   The calibration process can be followed on the s2terminal window.
   When the calibration is complete calibration values will appear on the PC.


Tube_preheat calibration
Calibrated ref value 4mA : 68
Calibrated ref value 15mA : 190
Measured Fb peak value 4mA : 58
Measured Fb peak value 15mA : 217

3. Press OK (unit display) once to accept the calibration data and a second time to return to the calibration menu.
   If the calibration was **successful** the colour of the text on the Preheat button will have changed from black to grey.
   If the calibration was **NOT successful** the colour of the text on the Preheat button will remain black. Repeat the calibration process.
   If the calibration is still unsuccessful after repeating it several times, R3810 X-ray generator and/or R3310 IO1 and/or the tubehead may be faulty.

2. Tube calibration - mA (Current)

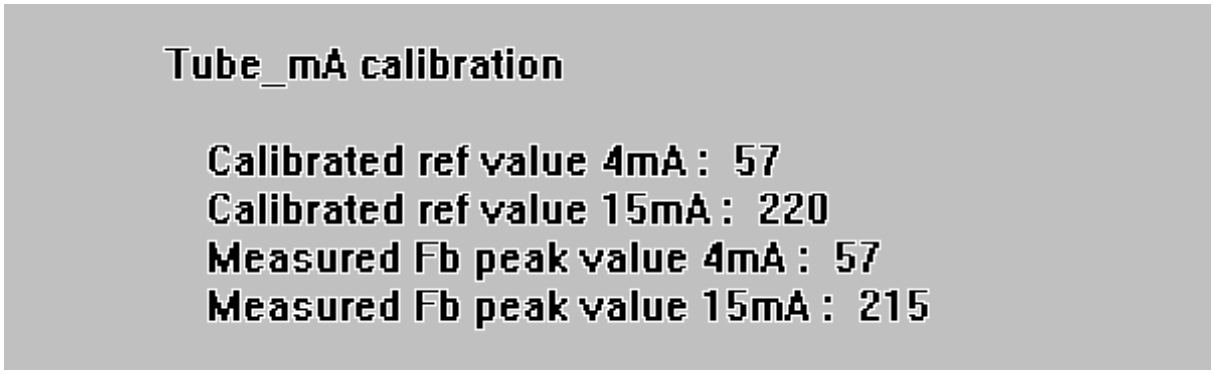
Calibrates the tubehead mA.

Prerequisites: preheat current.

1. Select mA.

2. **Protect yourself from radiation**.
   Repeat the procedure as described in preheat. The procedure will take about seven minutes.

   When the calibration is complete calibration values will appear on the PC.

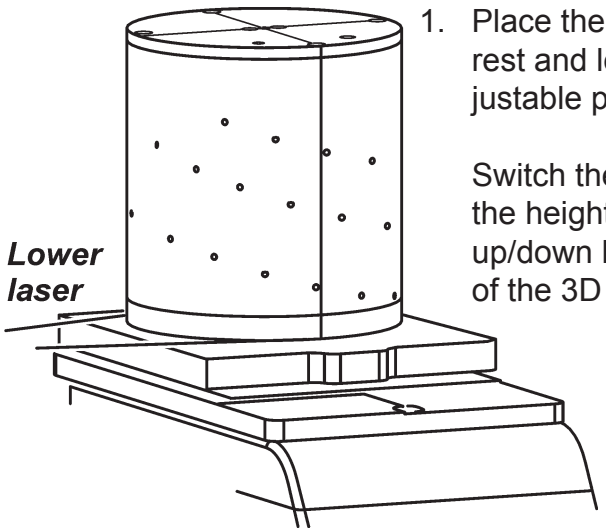

Tube_mA calibration
Calibrated ref value 4mA : 57
Calibrated ref value 15mA : 220
Measured Fb peak value 4mA : 57
Measured Fb peak value 15mA : 215

3. Press OK (unit display) once to accept the calibration data and a second time to return to the calibration menu.
   If the calibration was **successful** the colour of the text on the mA button will change from black to grey.
   If the calibration was **NOT successful** the colour of the text on the mA button will remain black.
   Repeat the calibration process.
   If the calibration is still unsuccessful after repeating it several times, R3810 X-ray generator and/or R3310 IO1 and/or the tubehead may be faulty.

   After the successful completion of Preheat and mA the X-ray electronics function correctly.

3. 3D geometry calibration

Calibrates the C-arm and rotation geometry.
Prerequisites: tubehead preheat and mA.

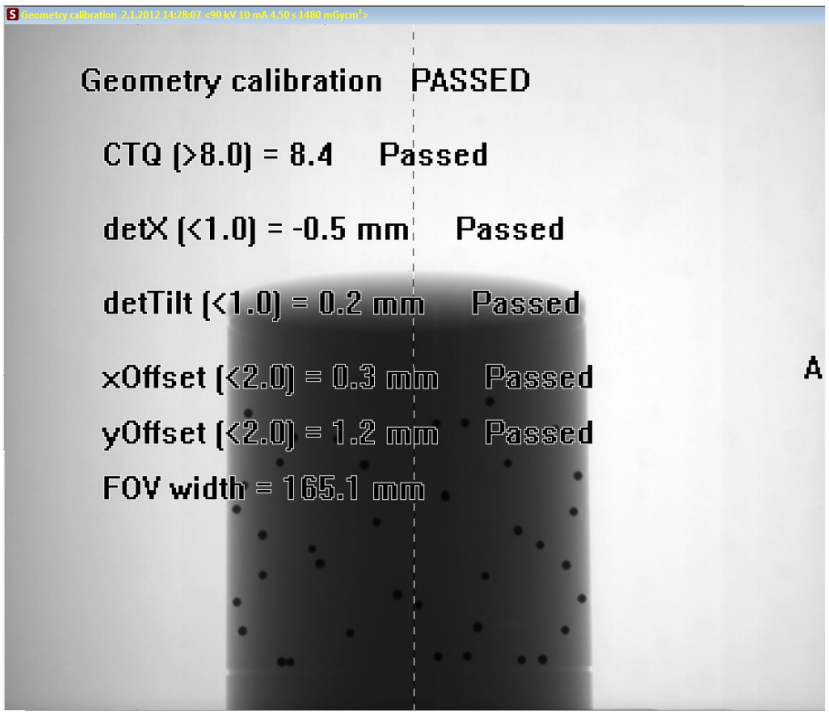


1. Place the adjustable phantom holder on the chin rest and level it. Place the 3D phantom on the adjustable phantom holder.

   Switch the patient positioning lasers on and adjust the height of the phantom, using **ONLY** the chair up/down keys, until the lower laser strikes the base of the 3D phantom.

2. Select **3D Geom**.

3. **Protect yourself from radiation**.
   Press and hold down the exposure button. After the exposure has been completed the it will take about five minutes for the geometry image to appear on the PC.


Geometry calibration PASSED
CTQ (>8.0) = 8.4 Passed
detX (<1.0) = -0.5 mm Passed
detTilt (<1.0) = 0.2 mm Passed
xOffset (<2.0) = 0.3 mm Passed
yOffset (<2.0) = 1.2 mm Passed
FOV width = 165.1 mm

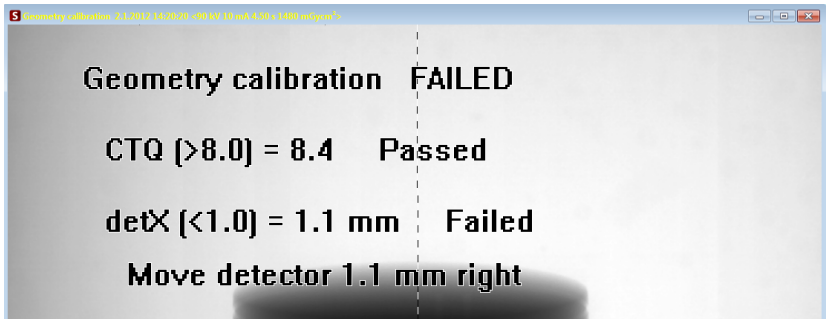
PASS
If the 3D geometric calibration is successful all the calibration values that appear on the image will be **Passed**.

Press OK (unit display) once to accept the calibration data.
The values of the X and Y coordinates that appear on the unit display will automatically zero.

Press OK a second time to return to the calibration menu.

After the successful completion of 3D geometry test the 3D sensor is correctly positioned in relation to the center of rotation of the rotating unit.

FAIL
If any of the calibration values are **Failed**, the geometric calibration has failed.



If the 3D geometric calibration has failed check the position of the lower laser by carrying out Z-laser check (see 5. Lasers Z (FOV)).
Reposition the light if necessary and then carry out the 3D geometry calibration again.
If the unit still fails the test then the 3D sensor must be adjusted manually.

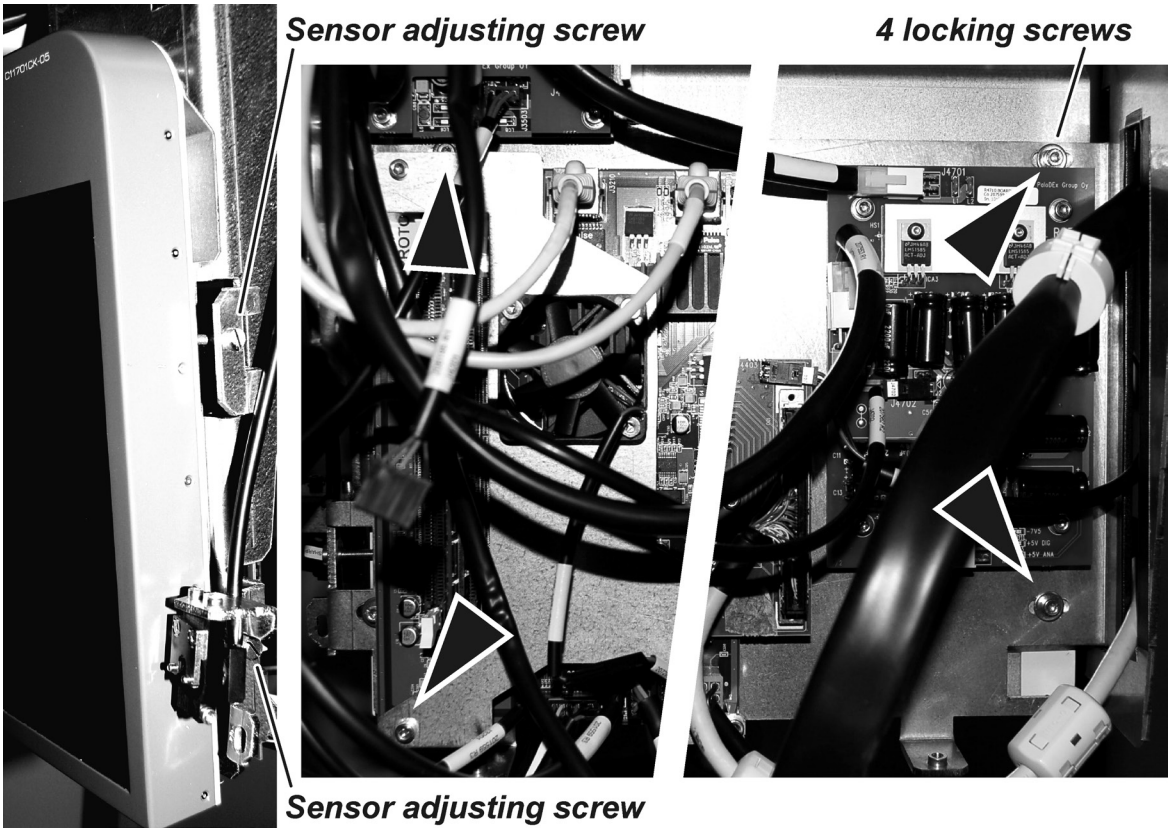
To adjust the 3D sensor see next section, **Adjusting the 3D sensor**.

Adjusting the 3D sensor

1. Remove the cover from the sensor side of the rotating unit. See section **10.2 The 3-D sensor** for information on how to remove the covers

2. Loosen the four locking screws that hold the 3D sensor in position.

3. Use the two sensor adjusting screws to the right of the 3D sensor (when viewed from the front) to adjust the detX (left/right) position and/or detTilt (tilt) position of the sensor.



4. Tighten the locking screws and then carry out the 3D geometry calibration test again.

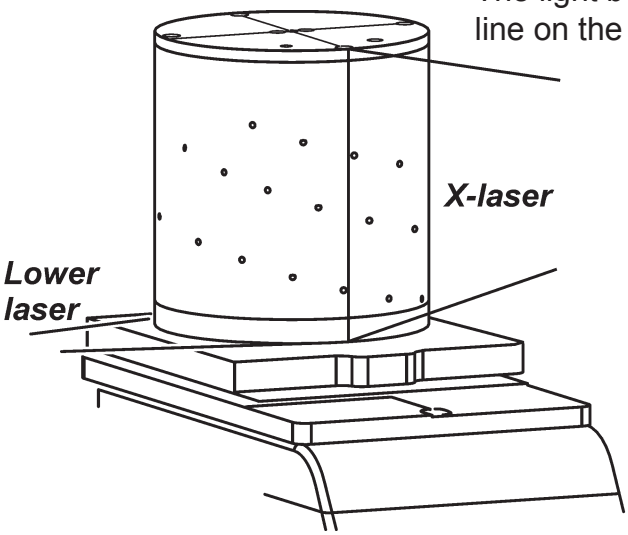
4. Lasers (X laser)

Checks the position of the X- laser.
Prerequisites: 3D geometric calibration.

1. Use and position the 3D phantom in the same way as for the 3D geometric calibration. Make sure that the lower laser strikes the base of the 3D phantom.

2. Select **Lasers**

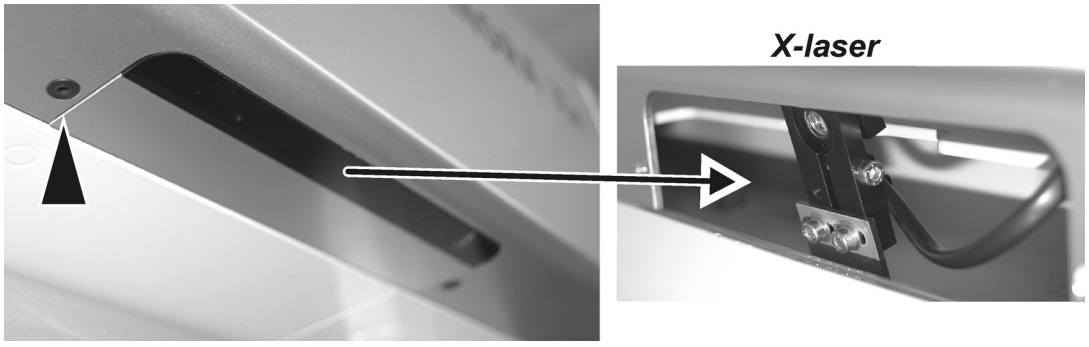
3. Press the Positioning lights key (remote control) to switch the light on. Check the position of the X-laser.
   The light beam must strike the appropriate vertical line on the 3D phantom.



Adjust the X laser if it is not correctly positioned.

Adjusting the X laser

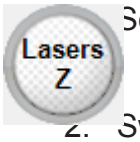
1. Remove the laser cover (2 screws) from the under-side of the upper shelf. The laser can be adjusted in the same way as the Lasers Z.



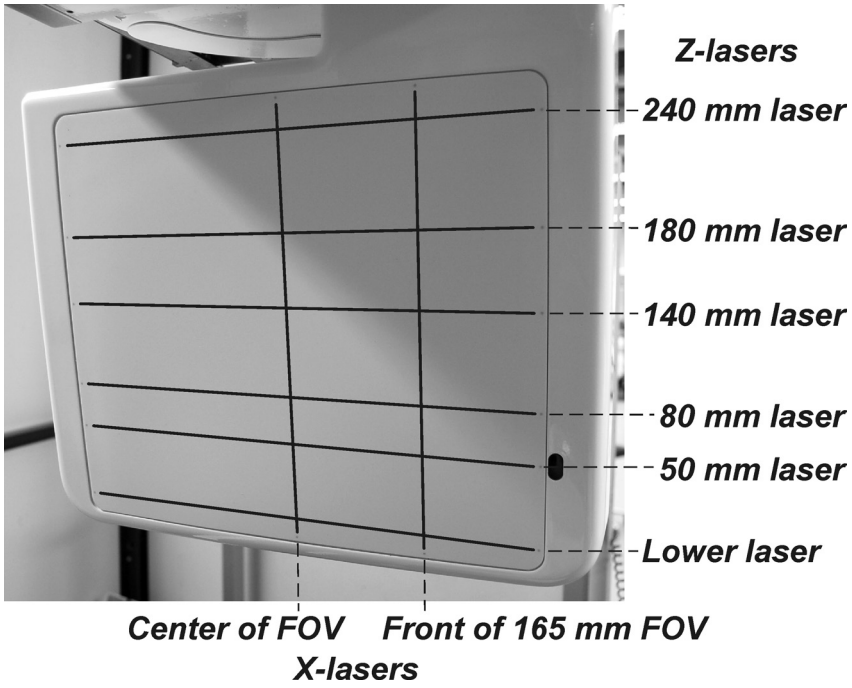
5. Lasers Z (FOV)

Checks the position of the field of view (FOV) lasers. The horizontal (Z) lasers and the vertical (Y) lazers.

Prerequisites: None



1. Select **Z Lasers**
2. Switch the patient positioning lasers on.
   Check the position of the horizontal (Z) and vertical (X) lasers. The small dots on the inner sensor cover indicate where the lights should be positioned. Adjust if necessary. See next section, **Adjusting the FOV-lasers**.

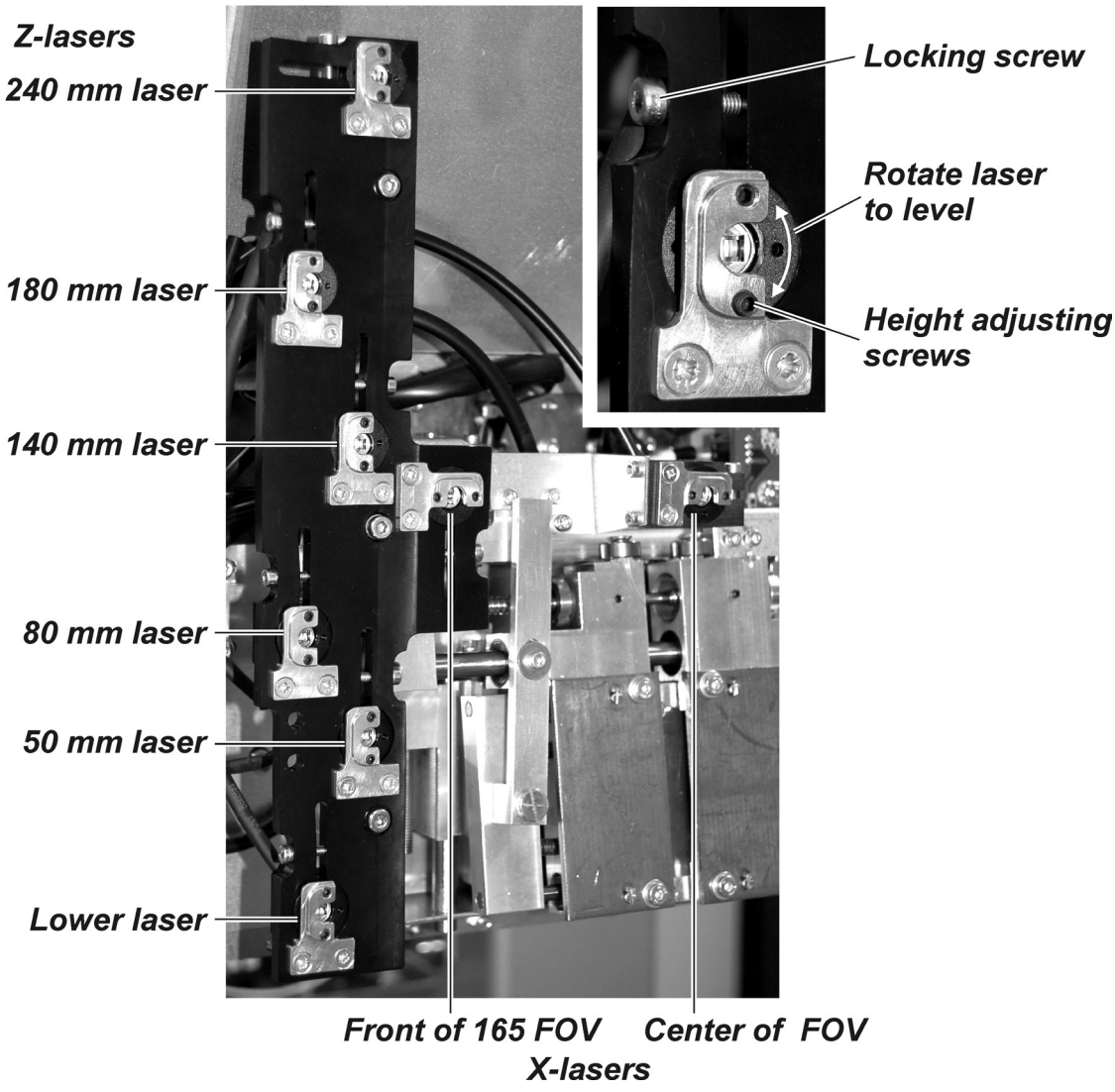


3. Briefly press the exposure button (NO X-RAYS are generated) to acknowledge that the check has been carried out.
   NOTE:
   If the exposure button is held down for too long, error code 200 **Exposure button pressed** will appear on the unit display. This will clear when the exposure button is released.

Adjusting the FOV-lasers

1. To adjust the lights remove the covers from the tubehead assembly. Section **11.1 Replacing the tubehead** describes how.

2. Loosen the locking screw and the adjust the height of the light with the height adjusting screws and level the light by rotating it.



3. Tighten the locking screw and recheck the position of the lights.

6. Collimator Y 3D (Vertical position)

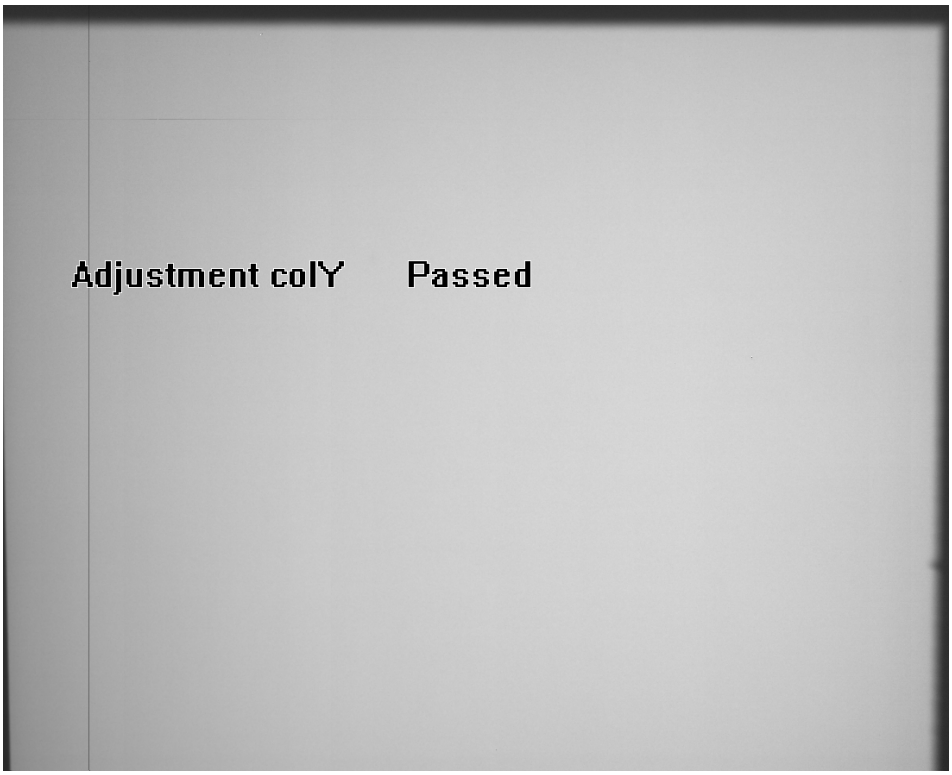
Calibrates the vertical position of the collimator assembly.
Prerequisites: 3D geometry.

1. Remove the 3D phantom and drive the chair down to its lowest position.

2. Select **Col Y 3D**.

3. **Protect yourself from radiation**.
   Press and hold down exposure button. The calibration exposure will take about 30 seconds.
   When the calibration is complete images will appear on the PC.

   PASS
   If the collimator Y position calibration is successful the calibration values that appear on the image will be **Passed**.



After the successful completion of collimator Y test the 3D collimator is correctly positioned in the Y-plane.

FAIL
If any of the calibration values are **Failed**, the collimator Y position calibration has failed.

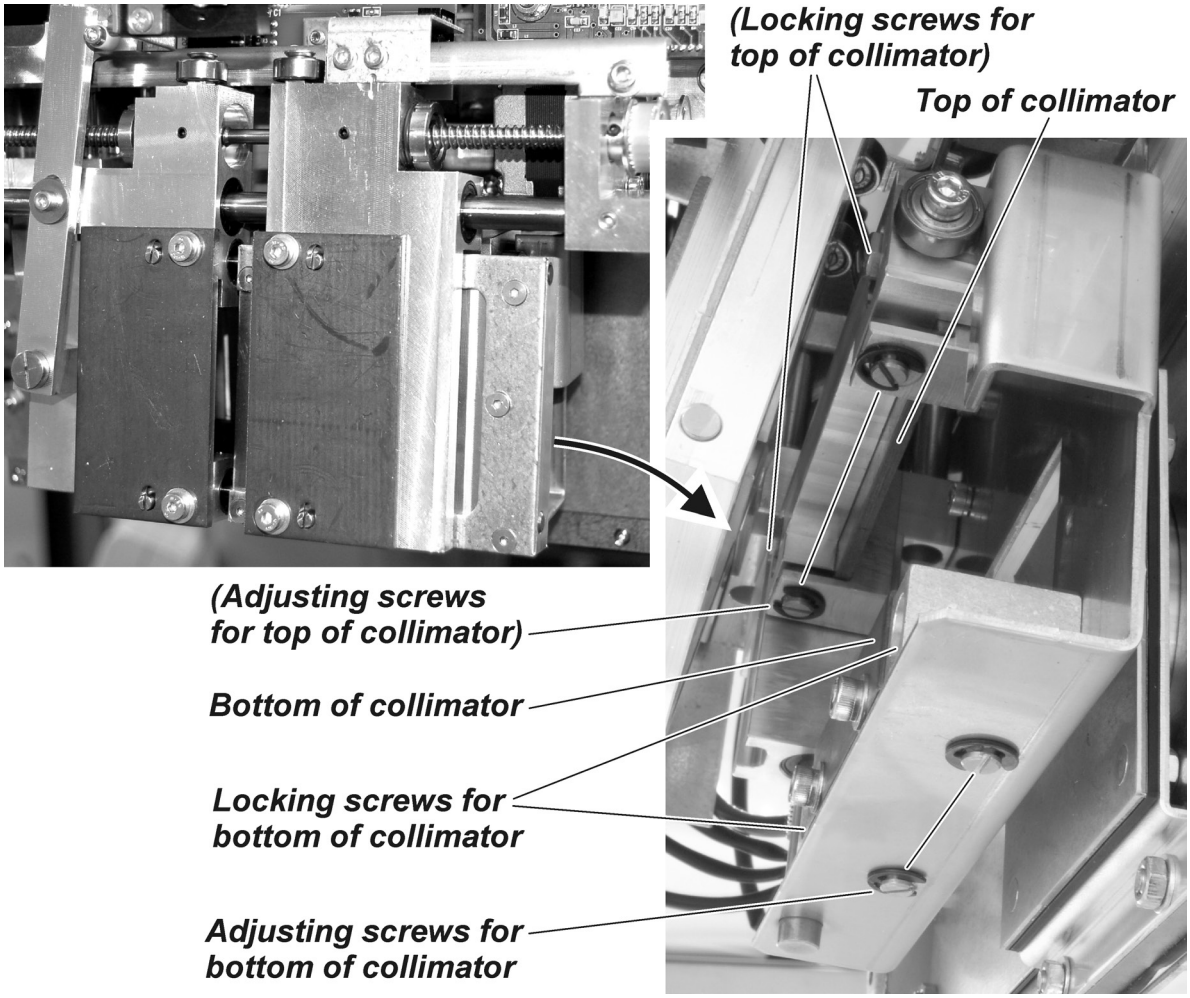
Repeat the collimator Y position calibration a second time, if it still does not pass, then the collimator must be manually adjusted.

To adjust the collimator follow the instructions that appear on the calibration image and refer to the next section **Adjusting the collimator**.

Adjusting the collimator

1. The bottom of the collimator can be adjusted.

   IMPORTANT NOTE:
   With some early units the bottom AND top of the collimator can be adjusted (picture below).


(Locking screws for top of collimator)
Top of collimator
(Adjusting screws for top of collimator)
Bottom of collimator
Locking screws for bottom of collimator
Adjusting screws for bottom of collimator

2. Loosen the top/bottom collimator locking screws and then adjust the position of the top/bottom of the collimator with the adjusting screws.

3. Retighten the locking screws and repeat the test. Readjust if necessary.

7. Pan X position (Panoramic)

Checks the position of the panoramic sensor. Horizontal position and tilt.

Prerequisites: Col Y 3D.

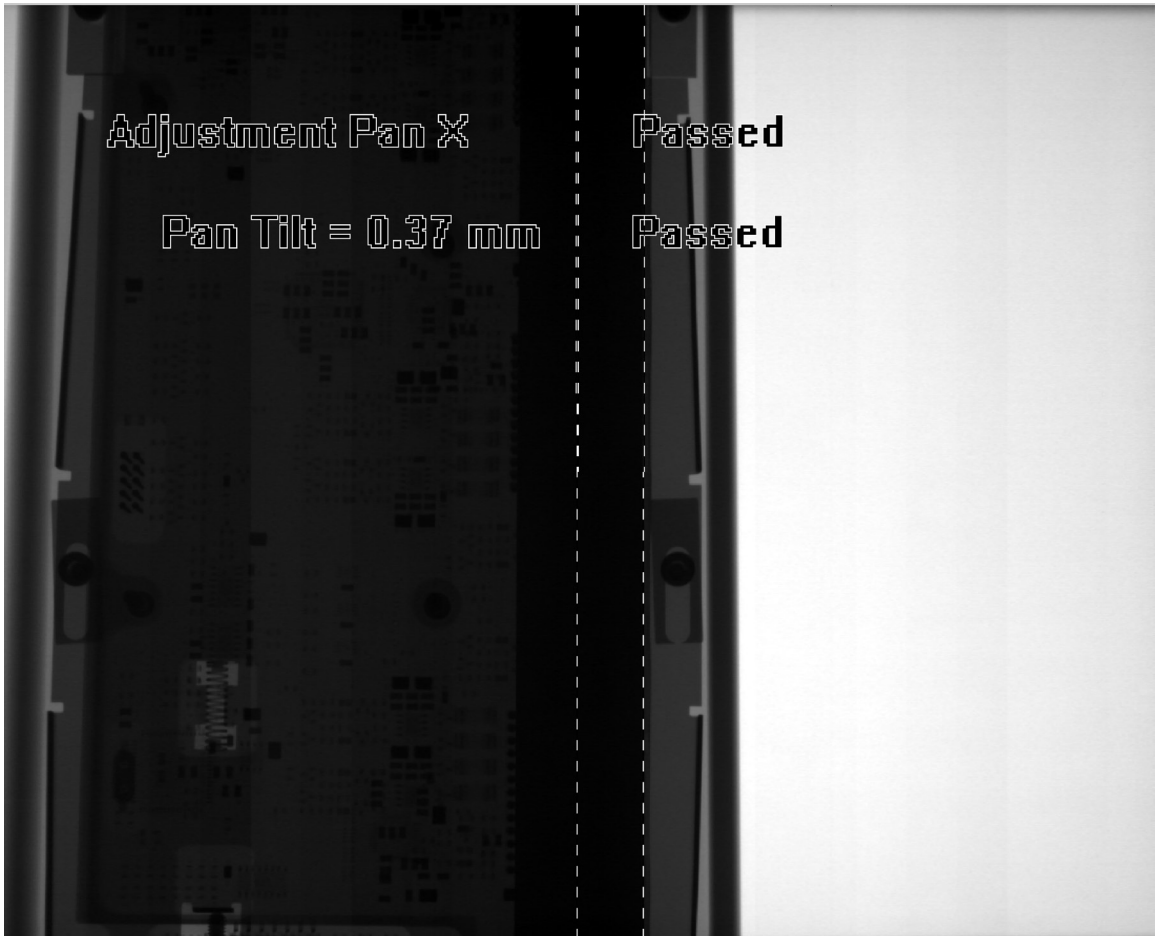
1. The unit must be in the same position as for the calibration test, Col Y 3D.

2. Select **Pan X**.

3. **Protect yourself from radiation**.
   Press and hold down exposure button. The calibration exposure will take about 30 seconds.
   When the calibration is complete images will appear on the PC.

   The calibration information that appears on the images is as follows:

– **ccdTilt** (pan sensor tilt).
  Passed, the sensor tilt must be less than 0.5 mm.
  If **Failed** the pan sensor must be adjusted.


Adjustment Pan X
Passed
Pan Tilt = 0.37 mm
Passed

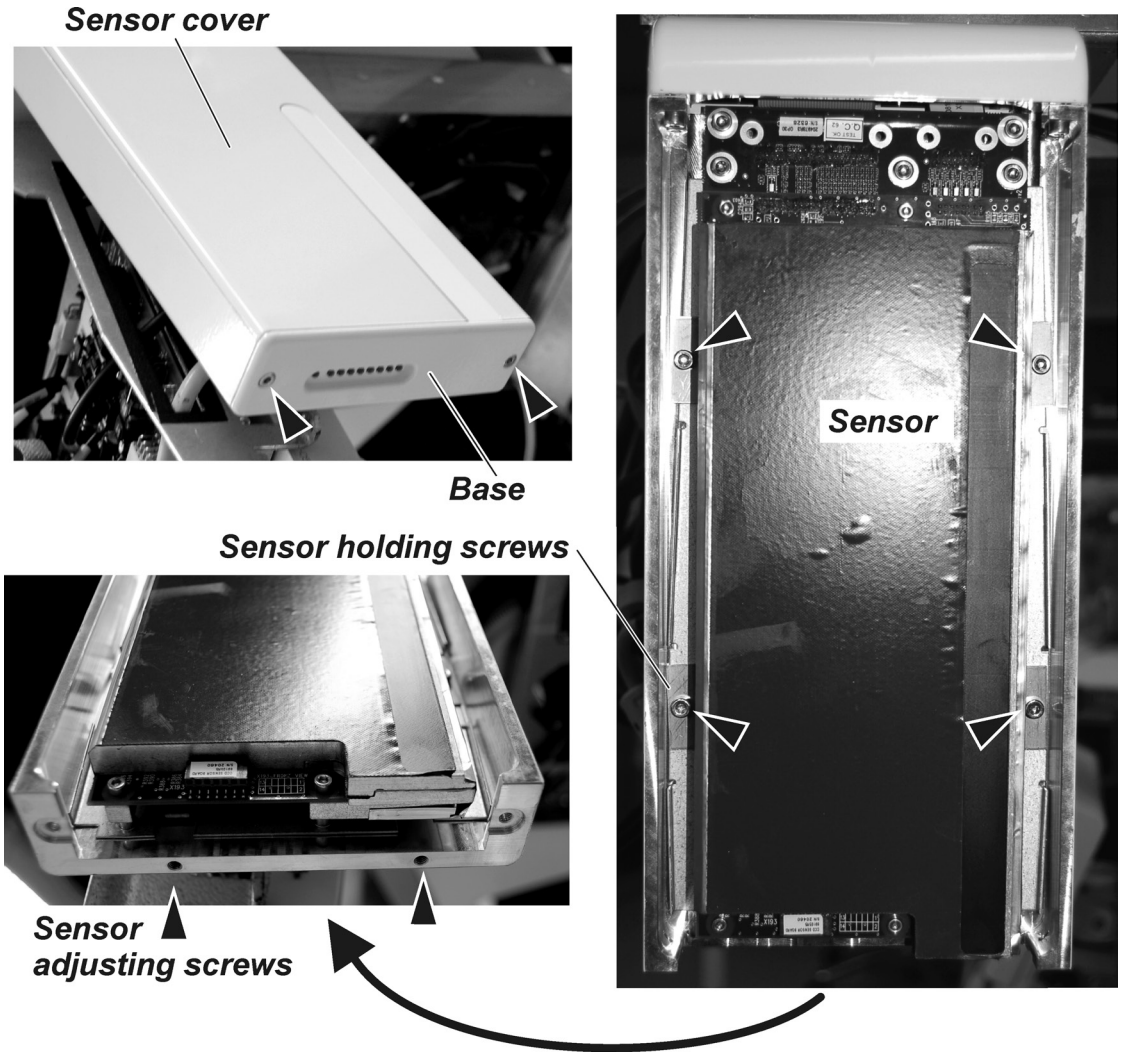
Adjusting the panoramic sensor

1. While holding the sensor cover and sensor base remove the two screws from the base of the panoramic sensor and then remove the cover.

2. Loosen the four screws that hold the sensor in position.

3. Adjust the height and/or tilt of the sensor with the two sensor adjusting screws in the base of the sensor support.

4. Recheck and readjust if necessary.
   After successful calibration the panoramic sensor will be correctly positioned.



8. Slit X position (3D)

Checks the horizontal position of the 3D aperture.

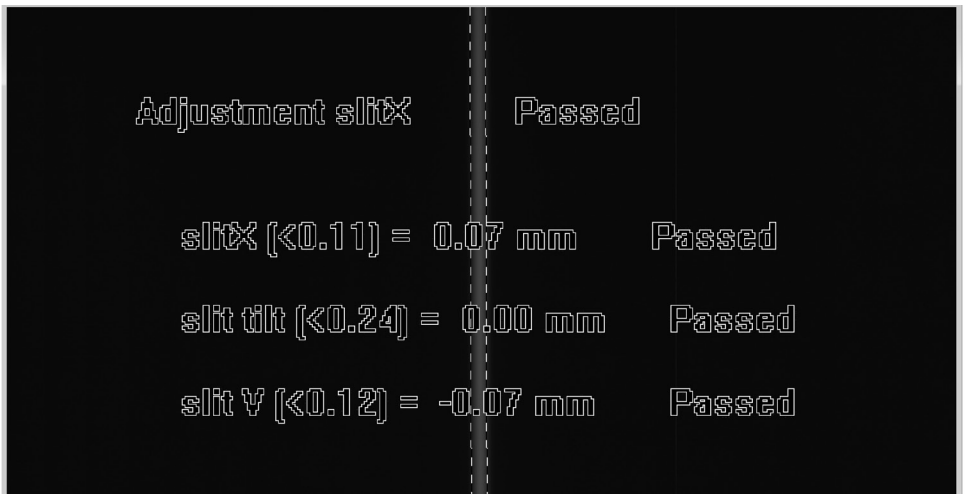
Prerequisites: Col Y 3D.

1. The unit must be in the same position as for the calibration test, Col Y 3D.

2. Select **Slit X**.

3. **Protect yourself from radiation**.
   Press and hold down exposure button. The calibration exposure will take about 30 seconds.
   When the calibration is complete images will appear on the PC.

   PASS
   If the aperture is in the correct position the slit position that appears on the image will be **Passed**.



Briefly press the exposure button (NO X-RAYS are generated) to acknowledge that the check has been carried out.

After the successful completion of Slit X the 3D aperture is correctly positioned horizontally.

FAIL
If the slit position is **Failed**, the aperture is not correctly centered.

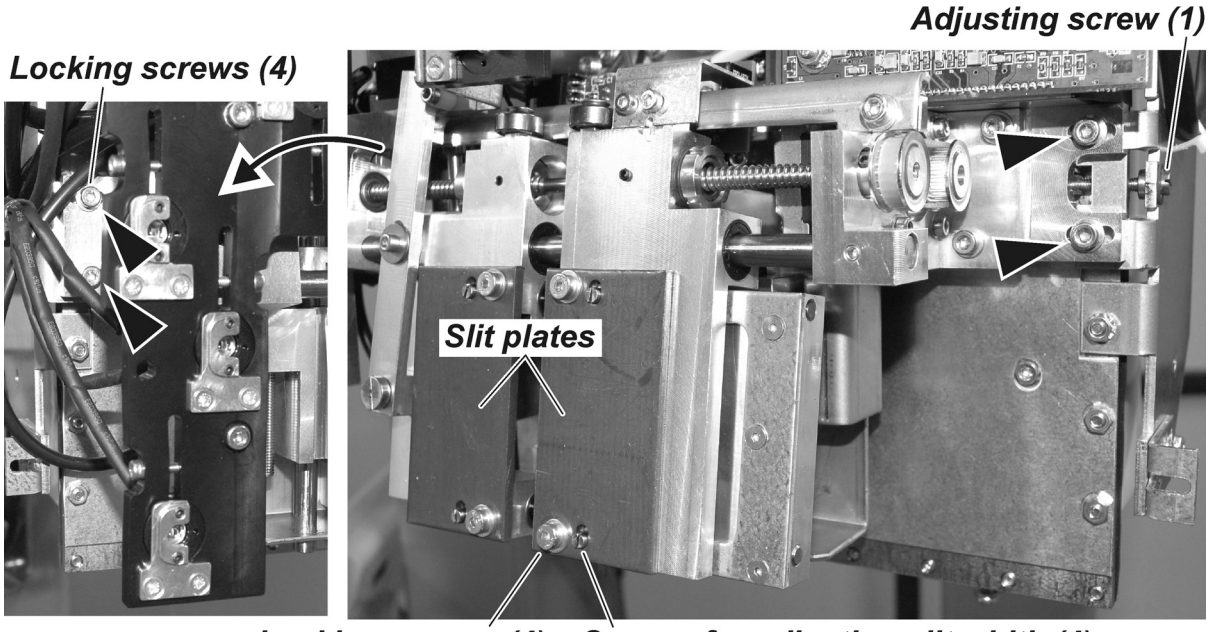
Repeat the slit X position calibration procedure once more. If it still does not pass the collimator must be adjusted manually.

To adjust the collimator follow the instructions that appear on the calibration image and refer to the next section **Adjusting the slit**.

Adjusting the slit

1. Loosen the four (4) collimator locking screws.

2. Adjust the horizontal position with the adjusting screw.
   Move to right = counter clockwise
   Move to left = clockwise



3. Retighten the holding screws and repeat the calibration. Readjust again if necessary.

   After the successful completion of SlitX the slit is correctly centered.

9. Slit size (3D)

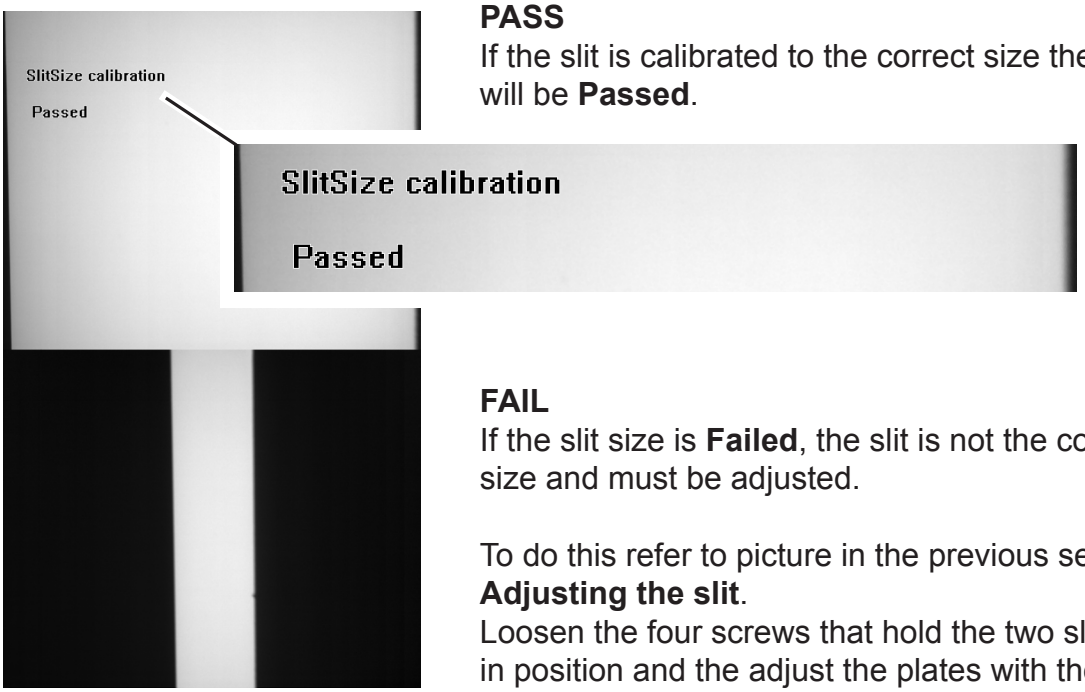
Calibrates the slit (aperture) size for the 3D FOVs.

Prerequisites: Col Y 3D.

1. The unit must be in the same position as for the calibration test, Col Y 3D.

2. Select **Slit size**.

3. **Protect yourself from radiation**.
   Press and hold down exposure button. The calibration exposure will take about 30 seconds.
   When the calibration is complete images will appear on the PC.



PASS
If the slit is calibrated to the correct size the image will be **Passed**.

FAIL
If the slit size is **Failed**, the slit is not the correct size and must be adjusted.

To do this refer to picture in the previous section, **Adjusting the slit**.
Loosen the four screws that hold the two slit plates in position and the adjust the plates with the adjusting screws.
After adjusting the slit size, recheck the slit position.

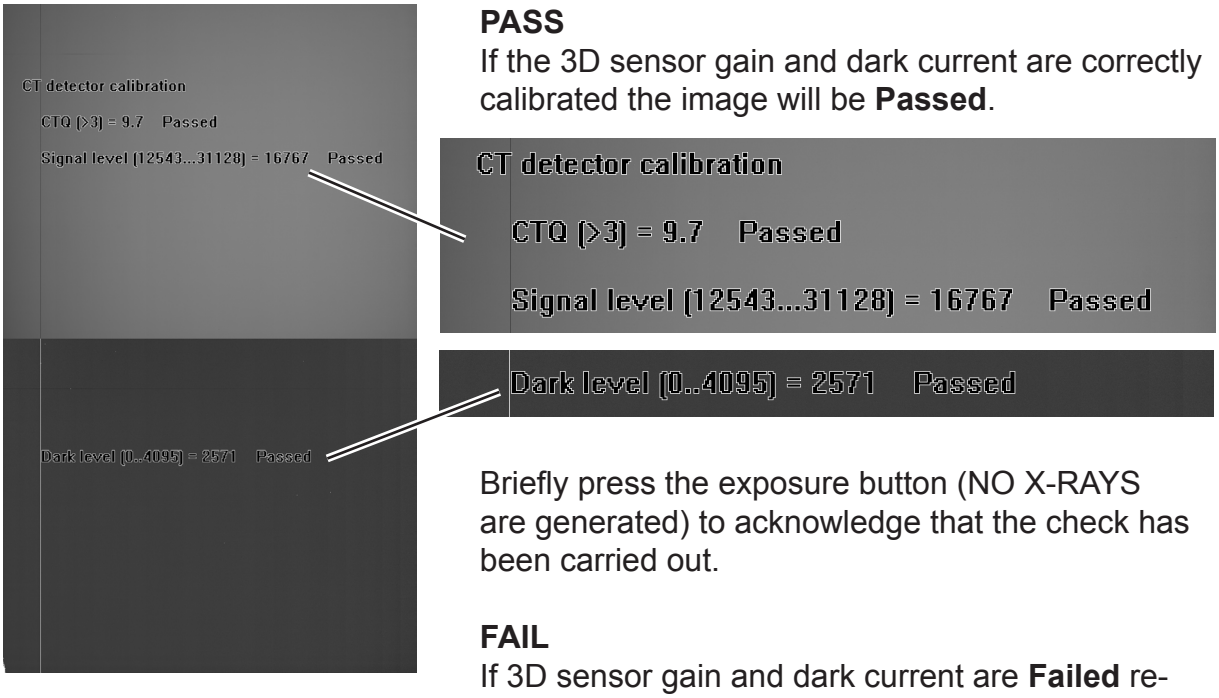
10. Panel pix fast mode (3D)

Calibrates the 3D sensor gain and dark current.
Precondition: Slit size.

1. The unit must be in the same position as for the calibration test, Col Y 3D.

2. Select **Panel pix fast mode**.

3. **Protect yourself from radiation**.
Press and hold down exposure button. The calibration exposure will take about 30 seconds.
When the calibration is complete an image will appear on the PC.



PASS
If the 3D sensor gain and dark current are correctly calibrated the image will be **Passed**.

Briefly press the exposure button (NO X-RAYS are generated) to acknowledge that the check has been carried out.

FAIL
If 3D sensor gain and dark current are **Failed** repeat the calibration.
If it fails a second time the 3D sensor is faulty and must be replaced.

11. Panel pix fine mode (3D)

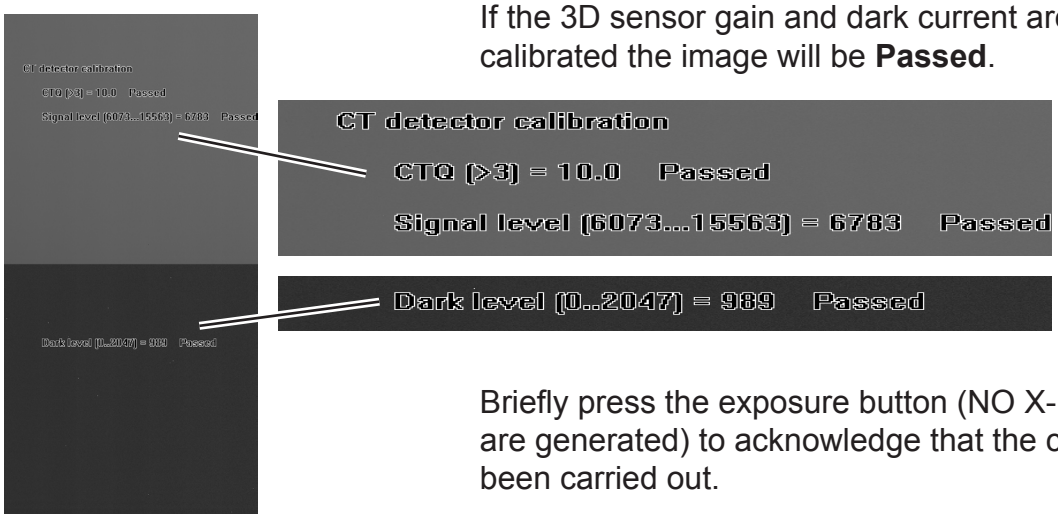
Calibrates the 3D sensor gain and dark current.
Precondition: Slit size.

1. The unit must be in the same position as for the calibration test, Col Y 3D.

2. Select **Panel pix fine mode**.

3. **Protect yourself from radiation**.
   Press and hold down exposure button. The calibration exposure will take about 30 seconds.
   When the calibration is complete an image will appear on the PC.

   PASS
   If the 3D sensor gain and dark current are correctly calibrated the image will be **Passed**.



   Briefly press the exposure button (NO X-RAYS are generated) to acknowledge that the check has been carried out.

   FAIL
   If 3D sensor gain and dark current are **Failed** repeat the calibration.
   If it fails a second time the 3D sensor is faulty and must be replaced.

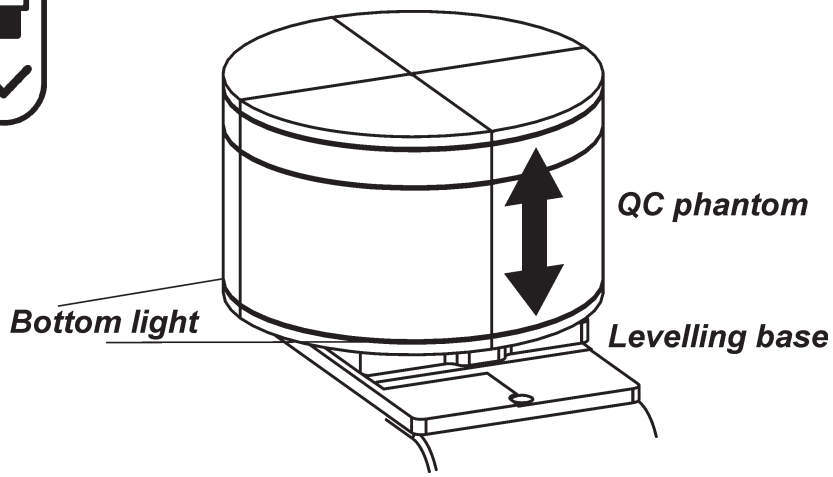
12. Quality Check (3D)

Checks that the unit is able to read the different density levels correctly. The QC phantom can also be used to check the positions of the laser lights.

Prerequisites: 3D Geom.

1. Place the levelling base on the chin rest and level it. Place the QC phantom onto the adjustable phantom holder.

2. Use the chair up/down keys **only** to adjust the height of the QC phantom so that the bottom light strikes the bottom line on the QC phantom.

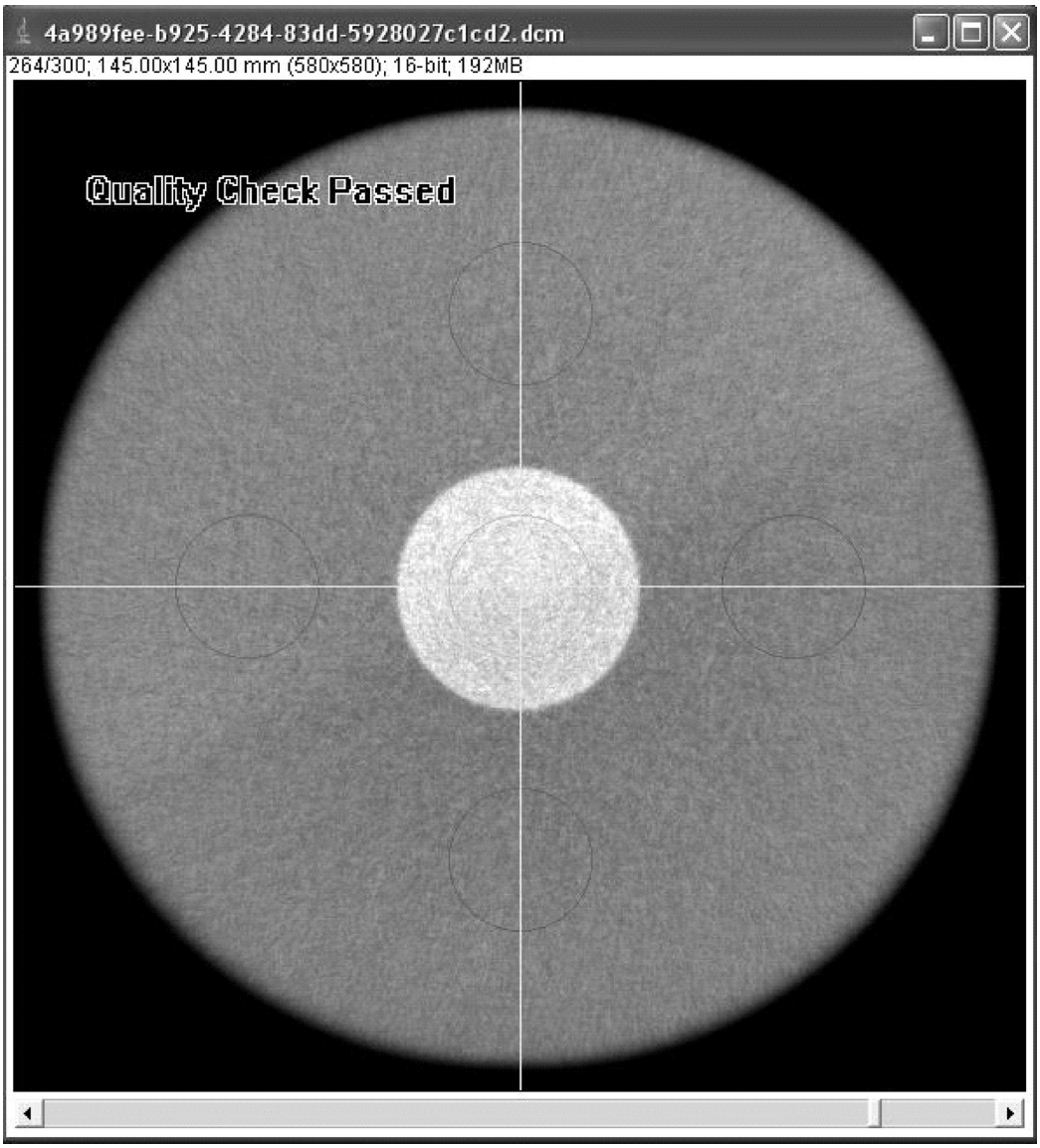


3. Select **QC**.

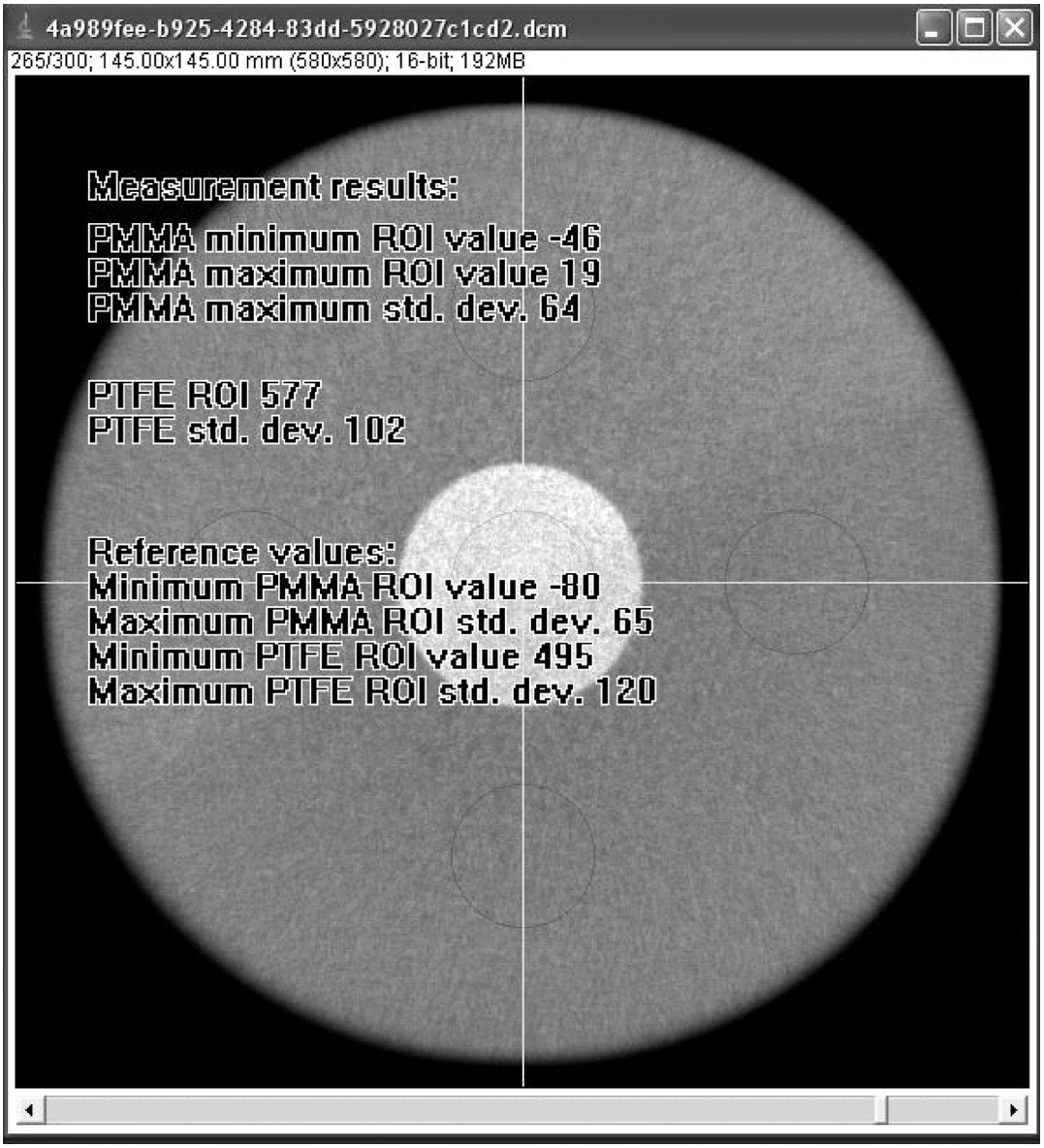
4. **Protect yourself from radiation**.
   Press and hold down exposure button. The C-arm will rotate twice around the phantom and the exposure will take about 15 - 20 seconds. Image reconstruction will take 3 - 5 minutes.
   When the check is complete open the 3D image (use 3D viewing software such as ImageJ).
   The unit reads the density at five different places through the 3D volume.

5. The calibration information that appears on the image is as follows:

– **Quality check**
Passed. Measurements results will also appear.



If **Failed**, check that phantom is correctly positioned. Check that there is no shadow from the slit on the image (check slit x, slit size and slit movement).


4a989fee-b925-4284-83dd-5928027c1cd2.dcm
265/300; 145.00x145.00 mm (580x580); 16-bit; 192MB
Measurement results:
PMMA minimum ROI value -46
PMMA maximum ROI value 19
PMMA maximum std. dev. 64
PTFE ROI 577
PTFE std. dev. 102
Reference values:
Minimum PMMA ROI value -80
Maximum PMMA ROI std. dev. 65
Minimum PTFE ROI value 495
Maximum PTFE ROI std. dev. 120

NOTE:
When the position lights are correctly positioned you will see a hole inside the bottom circle and cross hairs inside the top circle when you scroll through the volume. This indicates that the phantom is vertical.

After successful completion the unit is able to read the different densities correctly.

13. Collimator Y panorama (Panoramic)

Calibrates the position of the panoramic collimator in the vertical plane.

Prerequisites: Col X 3D.

1. The unit must be in the same position as for the calibration test, Col Y 3D.

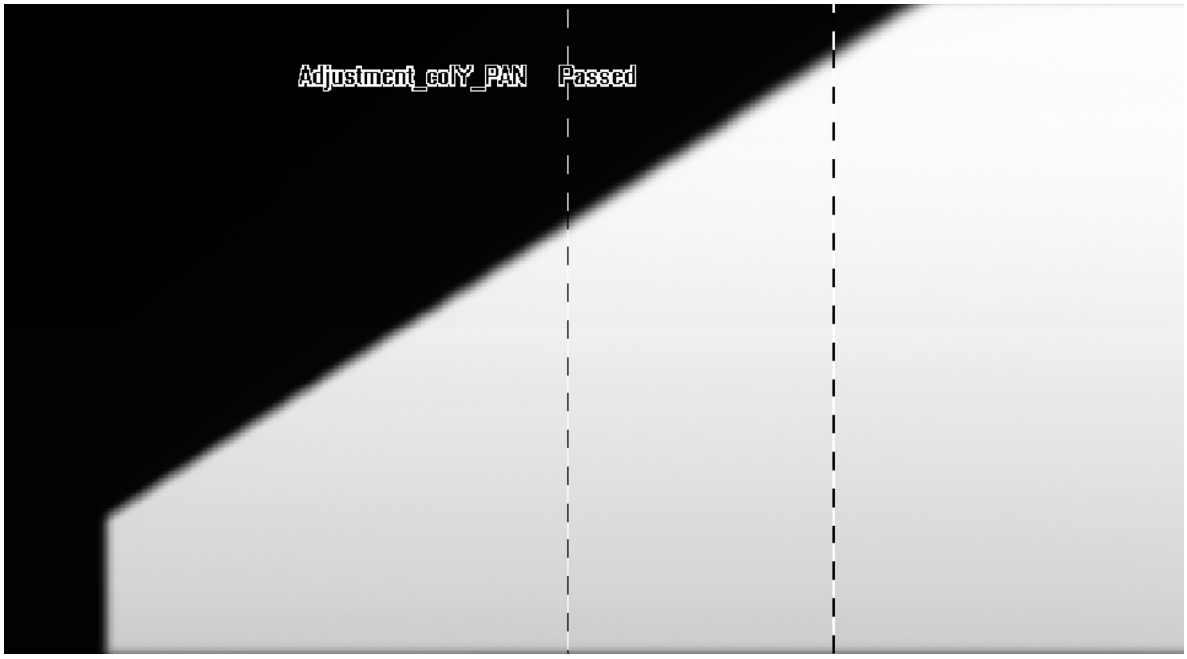
2. Select **Col Y Pan**.

3. Press the return key to drive the rotating unit to the start position

4. **Protect yourself from radiation**.
   Press and hold down exposure button. The calibration exposure will take about 30 seconds.
   When the calibration is complete images will appear on the PC.

   The calibration information that appears on the images is as follows:

– **Adjustment_colX_PAN** (position of the pan collimator).
  Passed the collimator is in the right position.



If **Failed**, adjust Col Y 3D. Most likely the failure is because the collimator is incorrectly positioned vertically.

After successful completion the panoramic collimation is correctly positioned in vertical plane.

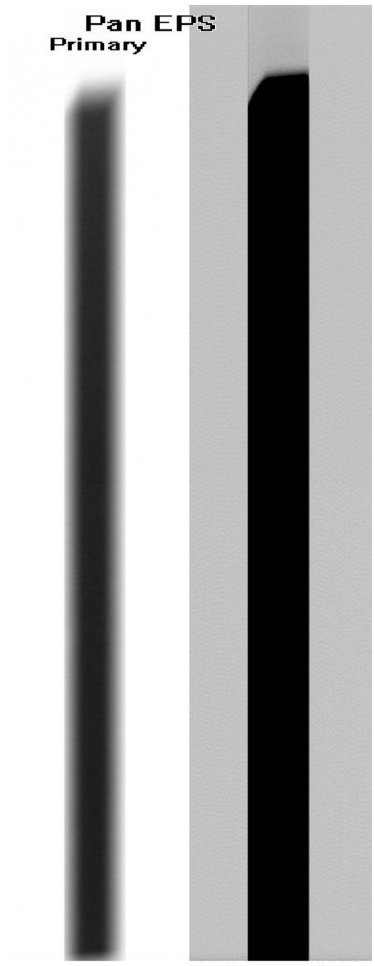
14. Pan EPS (Panoramic)

Calibrates the horizontal position of the pan sensor.
Precondition: Pan X.

1. The unit must be in the same position as for the calibration test, Col Y 3D.

2. Press the return key.

3. Select **Pan EPS**.



4. **Protect yourself from radiation**.
   Press and hold down exposure button. The calibration exposure will take about 30 seconds.
   When the calibration is complete an image will appear on the PC.

– To be correctly positioned (**Passed**) the exposed area (black) must be in or near the middle of the pan sensor field. You must be able to see some gray on both sides of the exposed (black) area.

  If the beam is not in the correct horizontal position, adjust the position of the panoramic sensor - **Pan X position**. If the beam is not correct vertical position, adjust the position of the collimator - **Collimator Y position**.

  After successful completion the pan sensor is positioned correctly.

15. Pan pix (Panoramic pixels)

Calibrates the panoramic sensor gain and dark current.

Prerequisites: Col X Pan.

1. The unit must be in the same position as for the calibration test, Col Y 3D.

2. Select **Pan pix**.

3. Attach the copper filter to the front of the collimator.

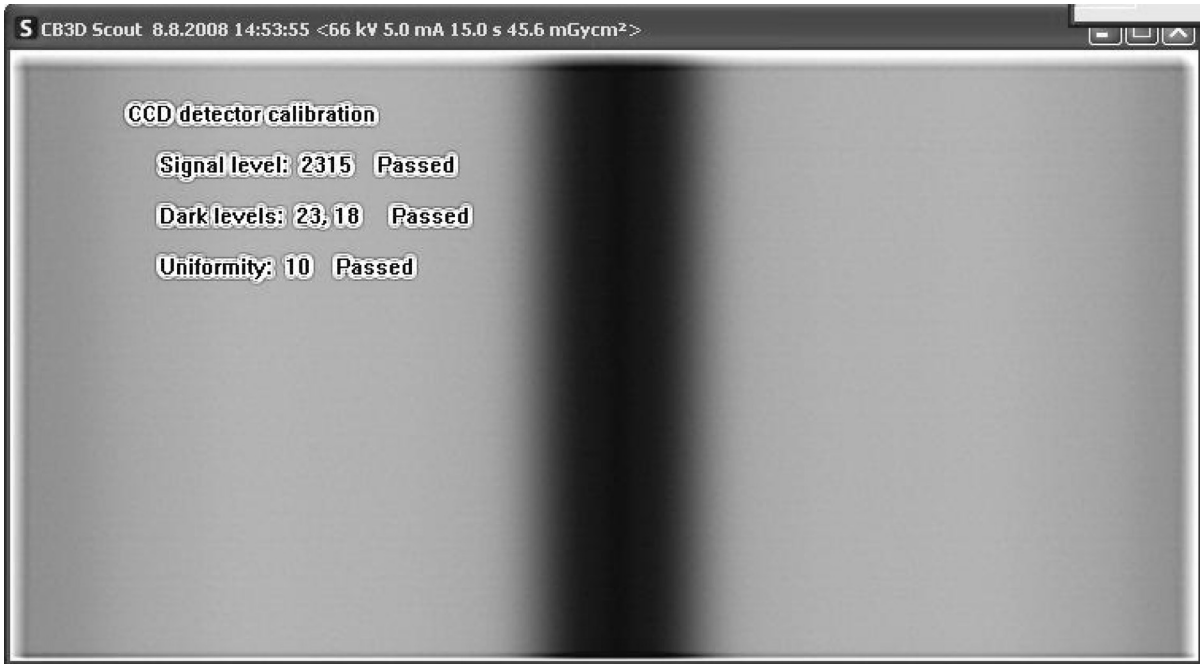
4. **Protect yourself from radiation**.
   Press and hold down exposure button. The calibration exposure will take about 30 seconds.
   When the calibration is complete an image will appear on the PC.

   The calibration information that appears on the images is as follows:

– **CT sensor calibration**
  Signal level: xxxx Passed.
  Dark levels: xx,xx Passed.
  Uniformity xx Passed.

  There must be no stripes on the image

  If **Failed**, Cu filter not in position. Recheck Pan X, and Slit size.



5. Remove the copper filter

   After successful completed the gain file and dark current compensation are correct.

16. Dose calibration small

If you do not have a DAP meter do not carry out the dose calibration, leave the value at the factory setting. If you have a DAP meter refer to the instructions below.

17. Dose calibration large

Refer to **16. Dose calibration small**.

18. Dose calibration adult pan

Refer to **16. Dose calibration small**.

19. Dose calibration child pan

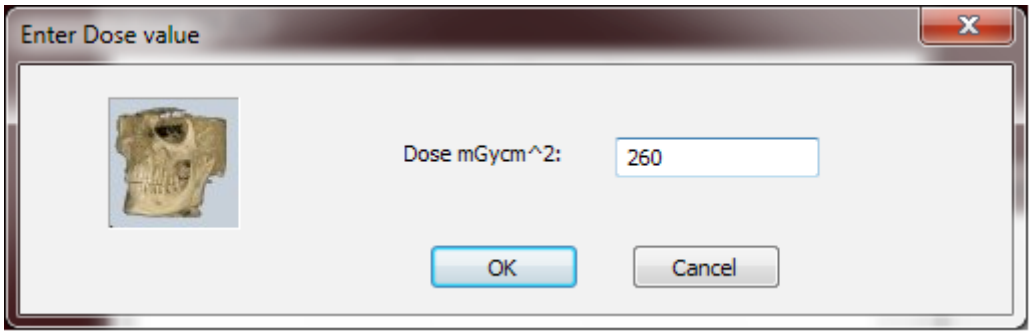
Refer to **16. Dose calibration small**.

All the above listed dose calibrations are all carried out in the same way.

1. Select the first dose calibration program, **Dose calibration small**.

2. **Protect yourself from radiation**.
   Position the DAP meter so that it will be able to read the radiation dose during exposure.
   Press and hold down exposure button to take an exposure. The exposure will take a few seconds.

The **Enter Dose Value** window will appear on the PC.



Enter dose value obtained from DAP meter in **Dose mGycm** field and click **OK**.

3. Repeat the process for the other dose calibrations, **Dose calibration large**, **Dose calibration adult pan** and **Dose calibration child pan**.

8.7 The Panoramic QA procedure (Optional)

1. Start the system and select the adult panoramic program as described in the user's manual.

2. Close the head support (rotate it towards the chair) and lock it in position with the head support locking lever.

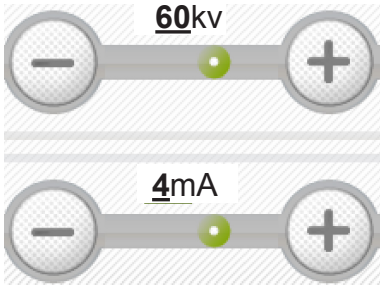
3. **PC**: Open the patient card in which the QA images are stored.

4. **PC**: Calibrate the contrast and brightness of the monitor to optimise its image quality. Refer to the SCANORA® Workstation software user manual for information on how to do this.

5. **PC**: Click the Image Capture button.

6. Touch the Panoramic button to select the Panoramic program mode.

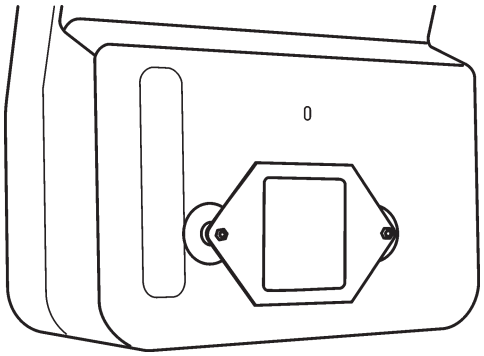
7. Select the adult panoramic program.



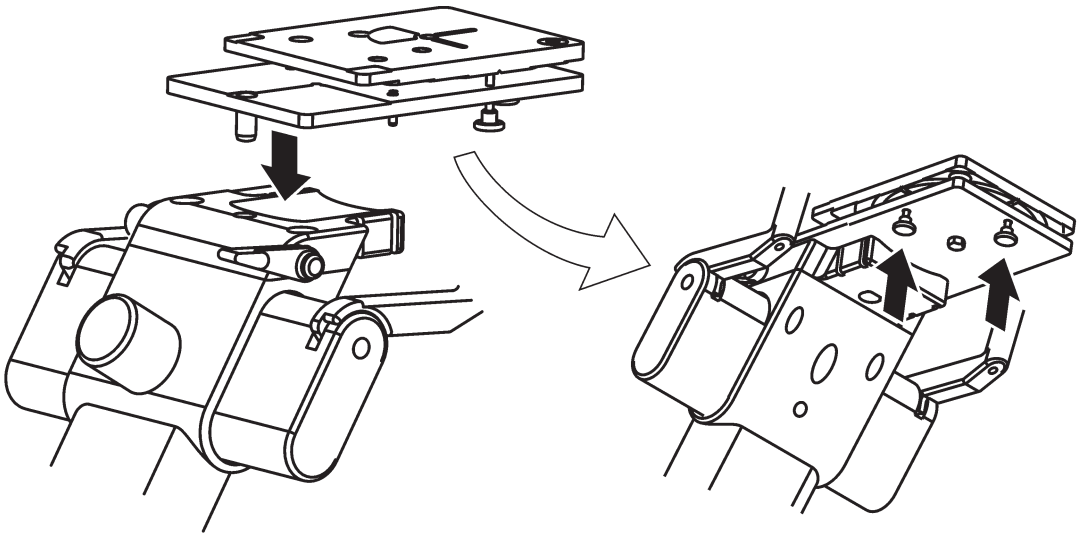
6. Select the minimum exposure factors, 60kV and 4mA.

7. Push the temple supports towards the chair so that the panoramic sensor will not hit them during the exposure.

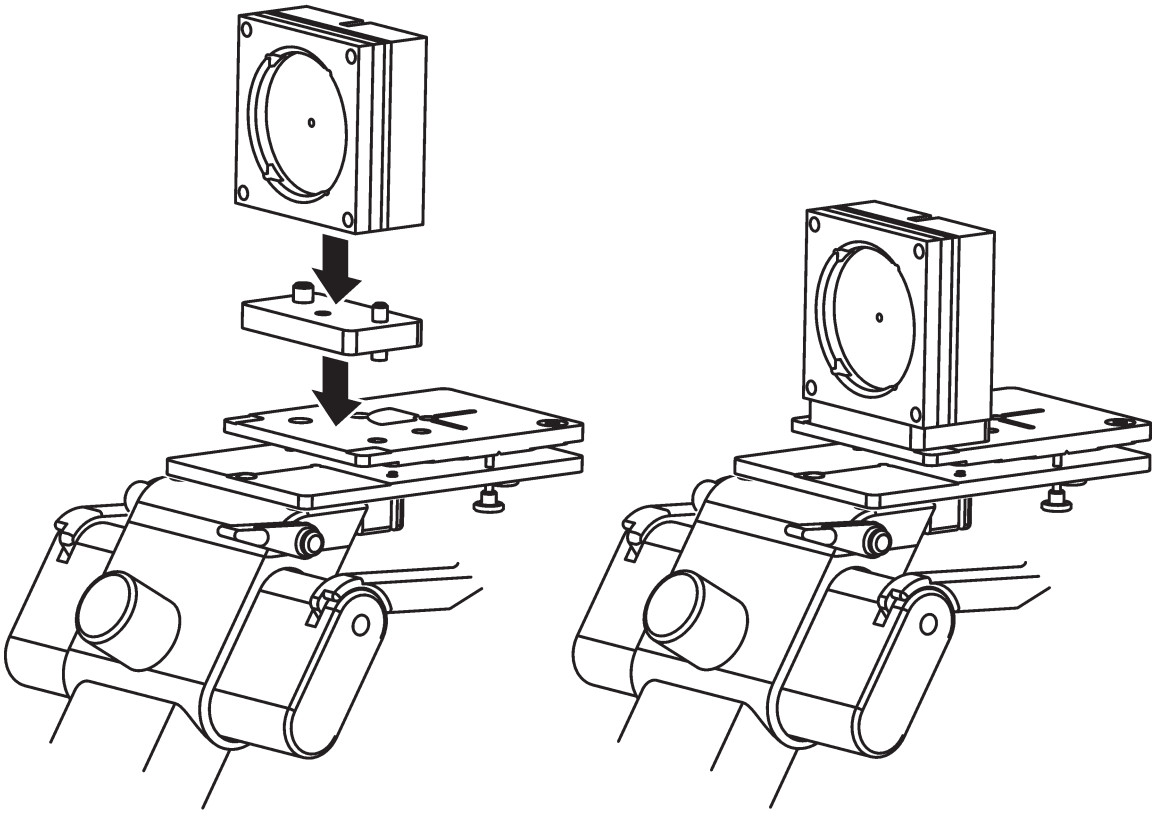
8. Attach the copper filter to the front of the tubehead assembly (in front of the collimator).



9. Place the adjustable phantom holder on the chin rest and then level the holder using the levelling screws on the under side. There is a spirit level on top of the holder.

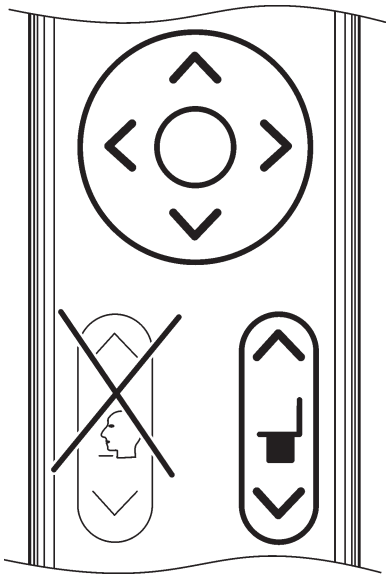


10. Place the panoramic ball and pin phantom on to the adjustable phantom holder and then place the test tool (line-pair phantom) on top of panoramic ball and pin phantom.

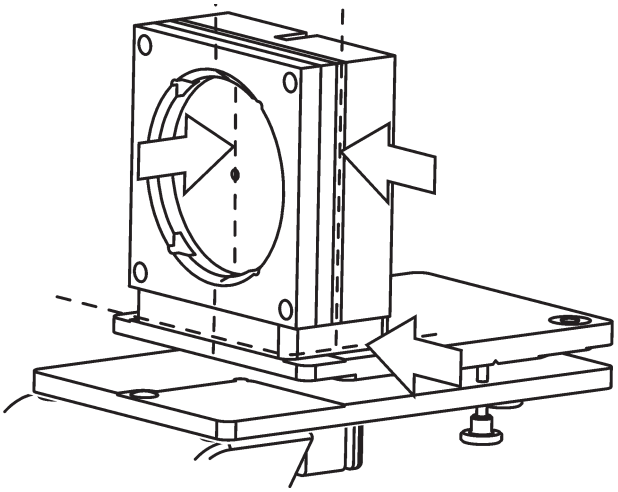


11. Press the Return key to drive the unit to the ready position.

12. Press the lights key to switch the patient positioning lights on.



13. Use the **Field of View positioning keys on the** remote control to position the test tool so that the focal trough light strikes the middle of the clear plastic layer sandwiched between the two aluminium layers.
Use the **Seat height adjusting keys** ONLY to position the horizontal light so that it strikes the lower edge of the ball and pin phantom.



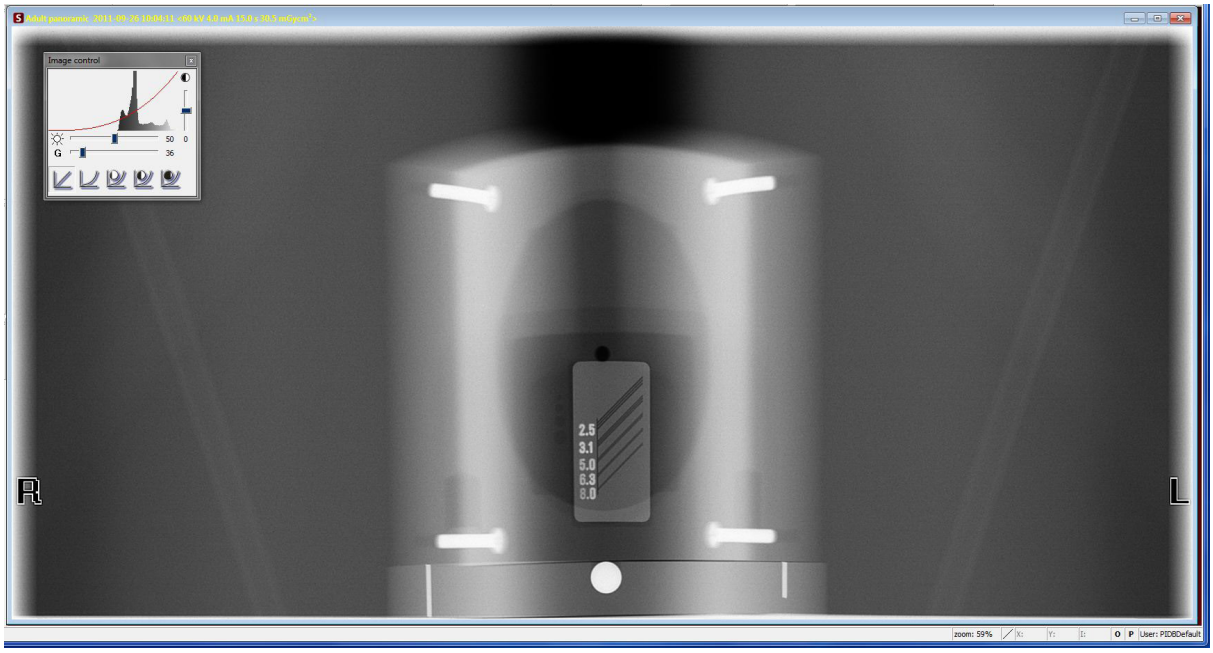
The midsagittal light beam should strike the middle of the test tool (the x axis position displayed on the control panel should be 0).

NOTE:
If the midsagittal light beam does not strike the middle of the test tool, carry out the 3D geometric calibration procedure to realign the unit.

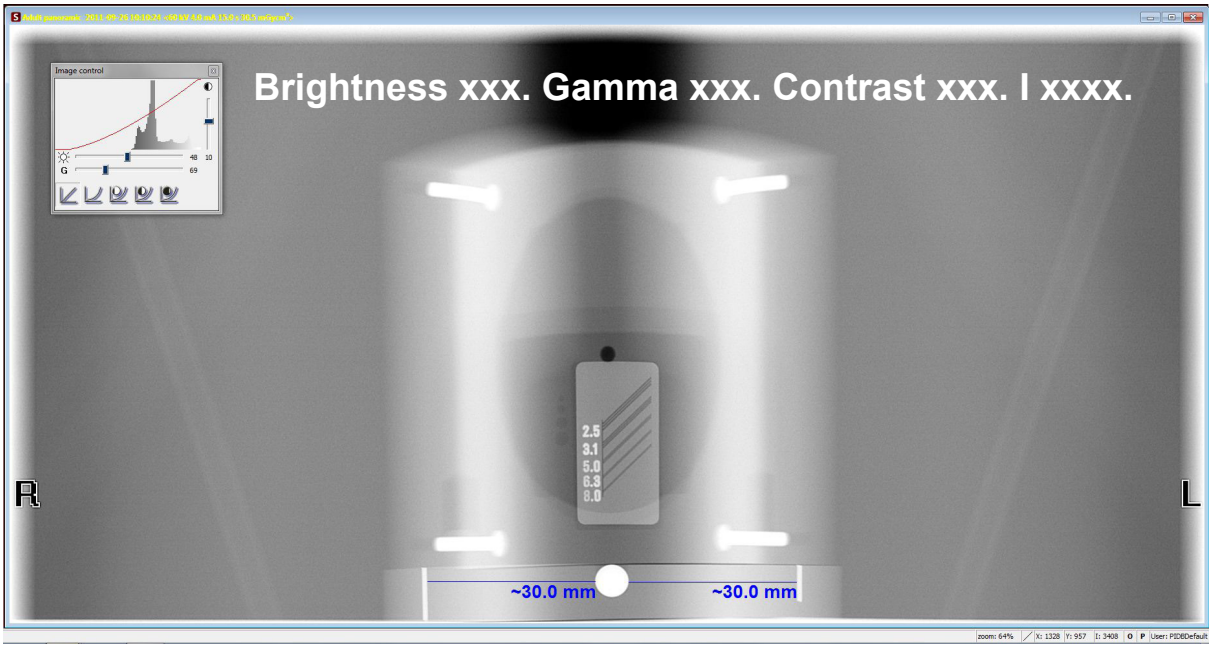
14. Protect yourself from radiation by standing behind a suitable x-ray radiation shield.
Press and hold down the exposure button. The exposure will last about 15 seconds.

15. **PC**: Click the Abort Capture button.

An image of the test tool and the panoramic ball pin phantom will appear on the unit display and then the PC.

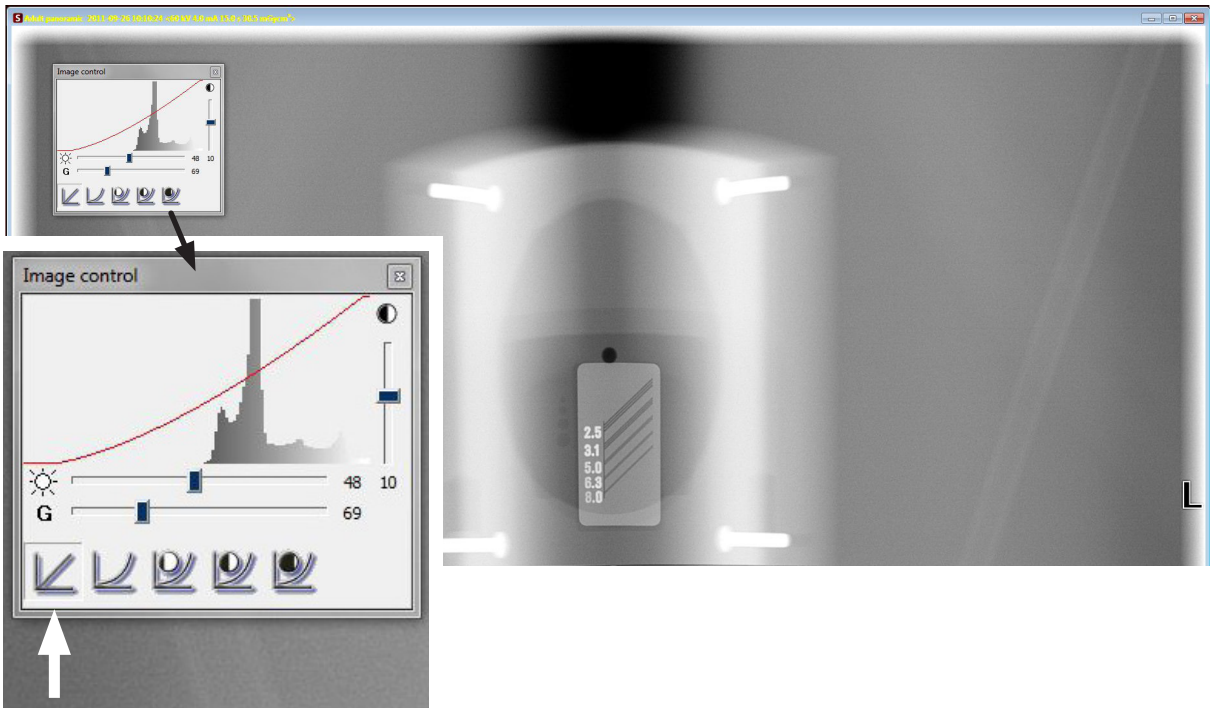


16. Open the original panoramic QA image that was taken when the unit was installed. It is stored in the QA patient card especially created for QA images.

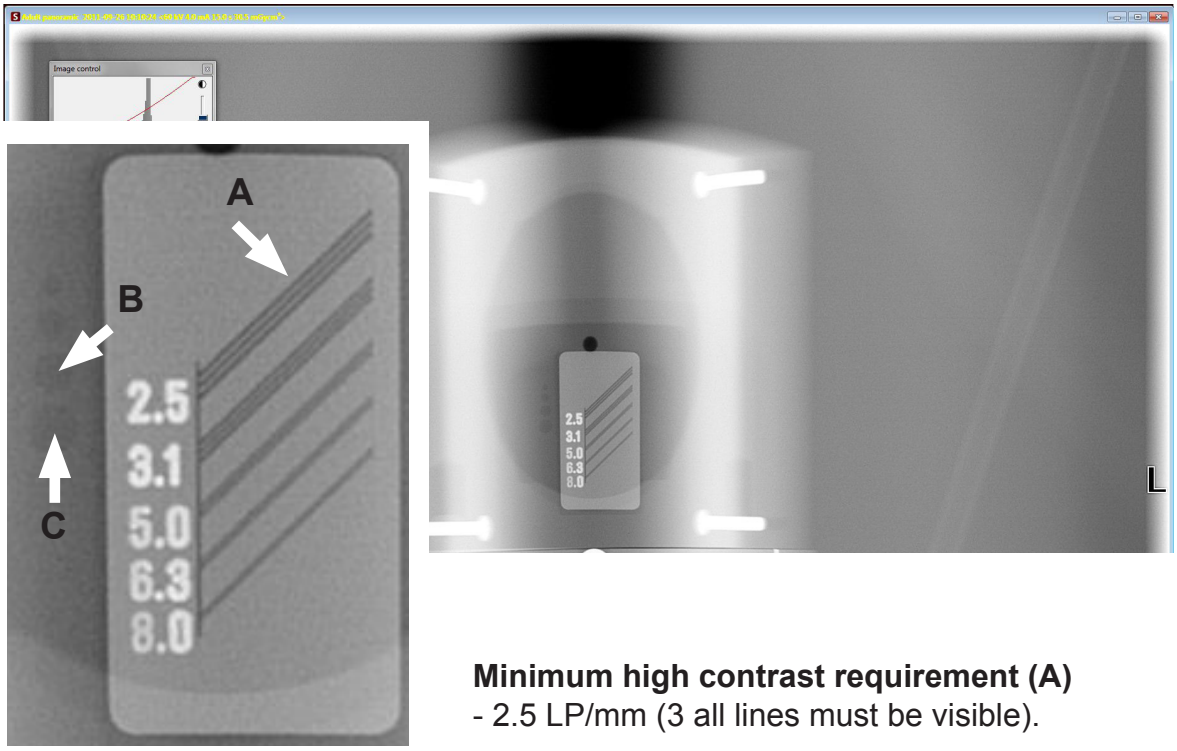


17. Use the **Image Control** tools to adjust the brightness, contrast and gamma correction levels of the panoramic test image that you just took so that the are the same as the levels that are written on the original panoramic QA image.
    Select the **linear** histogram before making adjustments.

    If there is no original panoramic image QA image (Panoramic upgrade) adjust the brightness, contrast and gamma correction levels of the image so that you can clearly see the line pair pattern in the center of the image.



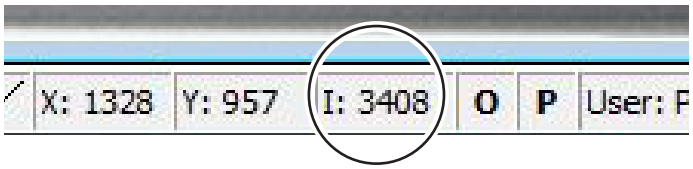
18. Now examine the image quality.
    The image contrast, grayscale and other image quality requirements are as follows:



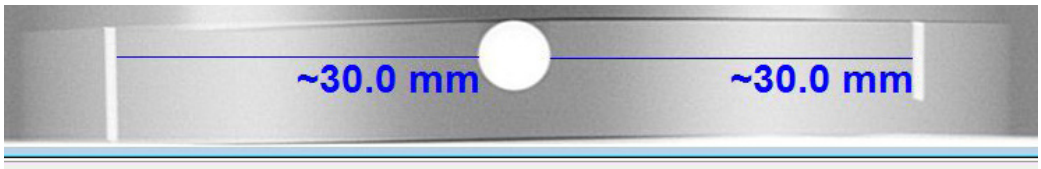
Minimum high contrast requirement (A)
- 2.5 LP/mm (3 all lines must be visible).

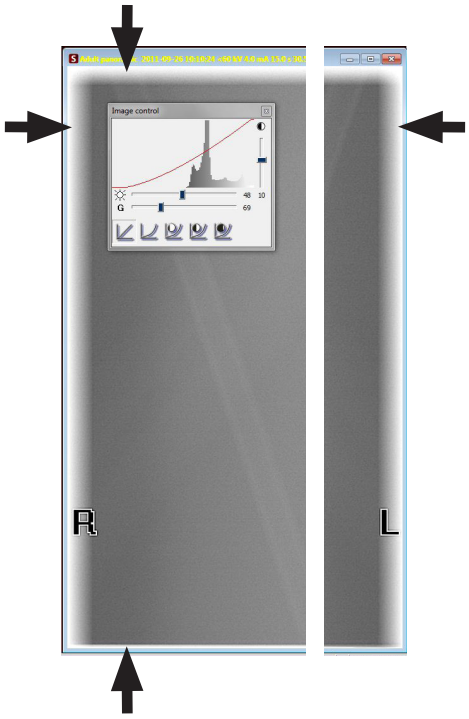
Minimum low contrast requirement (B)
- 2 holes minimum must be visible.

Grayscale value (C)
Position the cursor on the largest hole and then read the **I** (Original pixel) value in the bottom right-hand corner of the display.



Ball pin phantom dimensions
Use the measuring tools to check the dimensions of the ball pin phantom image.
The ball in the center must be round and the distances from the right-hand pin and the left-hand pin to the ball must be the same within ± 0.5mm.





Unexposed edge around the image
Without using the magnification tool you must be able to see an unexposed (white) border around the image.

Homogeneity of the image
The whole image should be homogenous and artifact-free, no lines, bands or speckling.

PASS
If the quality of the image meets the above requirements, the unit has passed the panoramic image quality check.

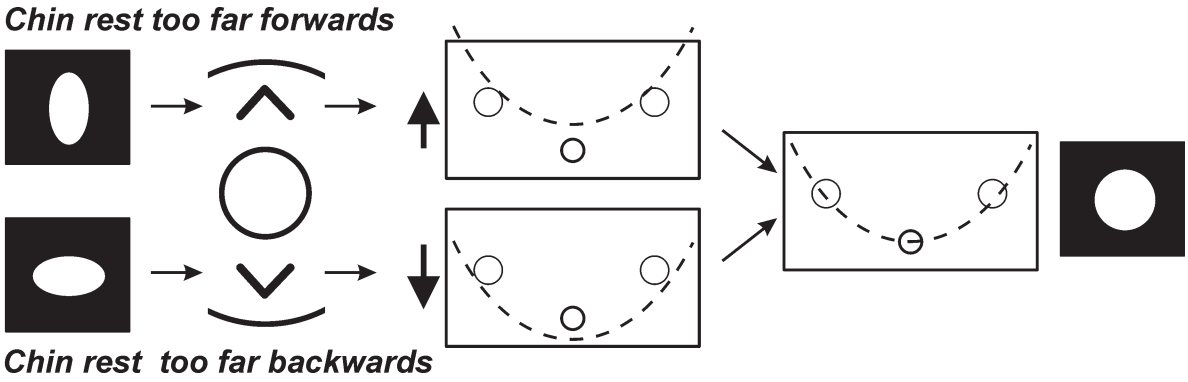
3. Touch the End Study button to exit the test.

FAIL
If the ball is not round the chair must be moved and then the focal trough light repositioned. See **Adjusting the position of the focal trough**.

If the quality of the image does not meet the above requirements check that the phantom is positioned correctly and repeat the test.
If it fails a second time see **Error codes and troubleshooting, Panoramic imaging**.

Adjusting the position of the focal trough

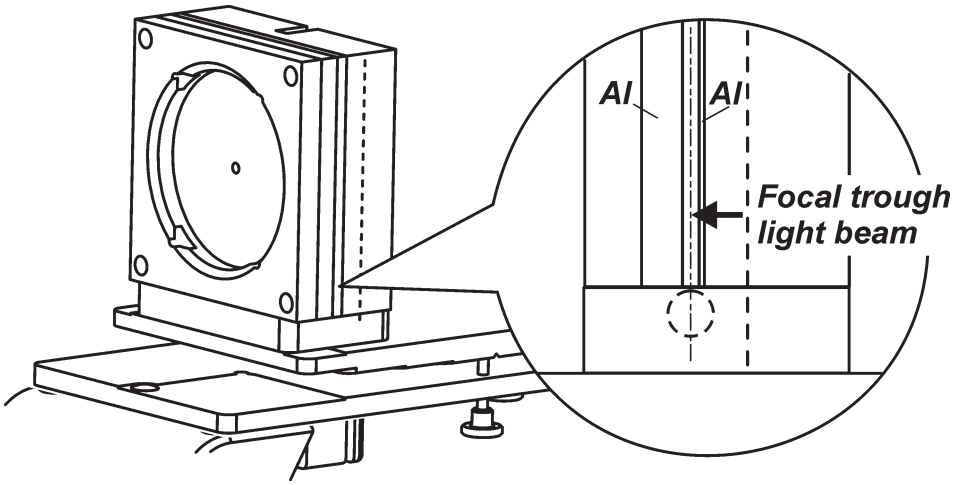
1. If the ball is not round the chin rest (chair) must be moved backwards or forwards until the ball until the ball is round.
   If the ball is longer in the vertical axis than the horizontal axis, move the chair backwards.
   If the ball is longer in the horizontal axis the move the chair forwards.



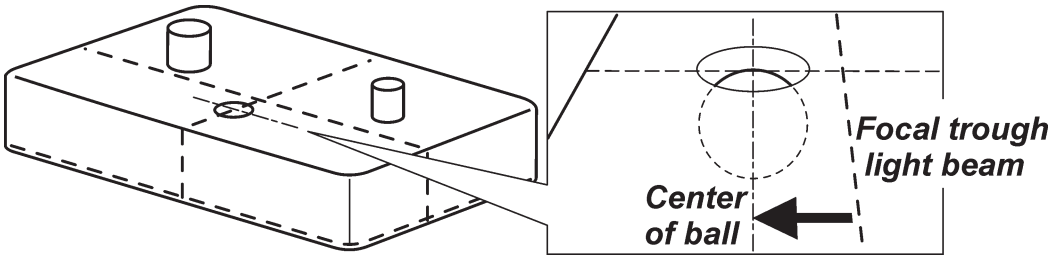
   Take another image and check and readjust the position of the chair until the ball is round and within the tolerances.

2. Now adjust the position of the focal trough light (NOT THE CHAIR) so that the light beam strikes the center of the focal trough.

   With the test tool (line-pair phantom) the light beam must be positioned so that it strikes the center of the acrylic layer sandwiched between the two aluminium layers.



With the ball and pin phantom the light beam must be positioned so that it strikes the center of the ball.



3. Take another image to confirm that the chin rest and focal trough light are correct.

9. Maintenance procedure

The maintenance procedure described below must be carried out at regular intervals in accordance with national regulations regarding the use, maintenance and of dental x-ray devices that are in force in the country in which the unit is installed.
In any event, the maintenance procedure must be carried out least one a year.
When taking measurements that require a multimeter, always use a calibrated digital multimeter (DMM).

9.1 Calibration and adjustment

Carry out the full calibration and adjustment procedure as described in the section 8. Unit calibration and adjustment. Note that this procedure includes mA/kV calibration

9.2 Ground test

Disconnect the unit from the mains before carrying out the next test.
Check the safety ground continuity by measuring the grounding resistance between the ground pin on the connector of the mains power supply cable and any metal part of the unit The resistance MUST be <0.2 ohm.

9.3 DAP calibration

If the unit is used in a country or place where the an exact DAP value is required (not just nominal values), measure the DAP values using a DAP meter of approved accuracy to measure the exact DAP values. These values should then be used during Calibration and adjustment.

DAP values
High resolution 3D, Large - 2000-2700 mGy
Adult panoramic - 65-135 mGy
Child Panoramic - 55-78 mGy

9.4 Motor movements

Switch the unit off and then manually rotate the rotating unit to check that all the stepper motor move freely and without any looseness.

In turn, press the position keys on the remote control (chair - backwards/forwards; c-arm - left/right; chin rest - up down; chair up/down) to check motor operation. The motors must operate smoothly and without any noise.

Switch the x-rays off and then take an exposure to check that the motors used to take an exposure operate smoothly and without any noise.

If you suspect that any of the belts are loose tighten them.

9.5 Position detectors

In turn, press the position keys on the remote control (chair - backwards/forwards; C-arm - left/right; chin rest - up down; chair up/down) to make sure that the unit assemblies stop moving at the extreme limits of their movement.

9.6 Mains power supply cable

Check the condition of mains power supply cable and replace if it is damaged.

9.7 Tubehead

Make sure that oil is not leaking from the tubehead.

9.8 Covers and Labels

Check that all covers are correctly installed and in good condition. Also check that all the labels are attached to the unit and that they are all legible.

9.9 Fire risk

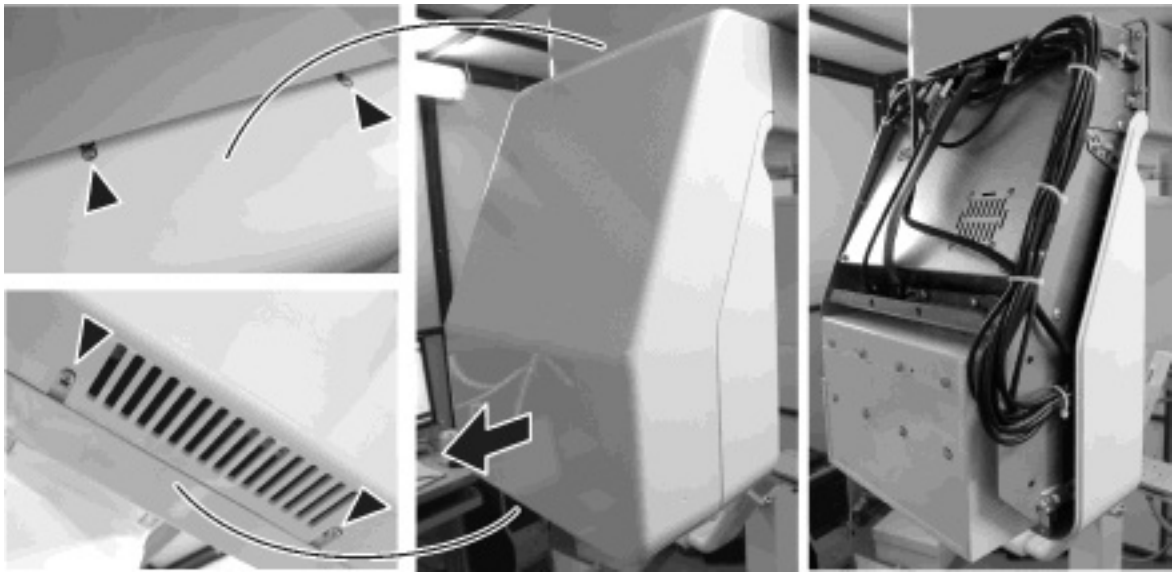
WARNING: Disconnect the unit from the mains before carrying out the next check.
Use a vacuum cleaner to remove all dust that has accumulated inside the unit to eliminate the risk of fire.

10. Replacing parts

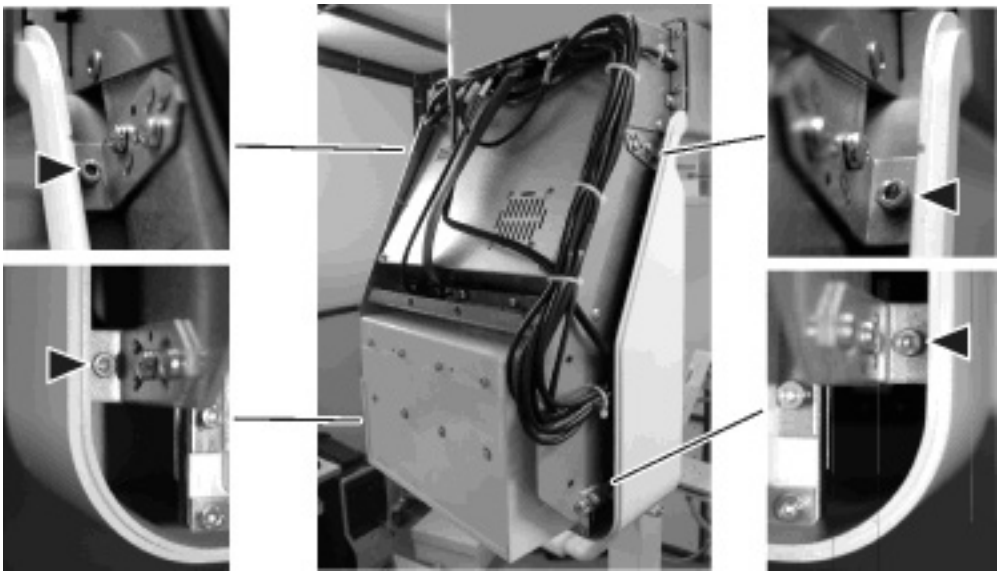
Before replacing any parts switch the unit off and disconnect/disable the power supply.

10.1 The tubehead.

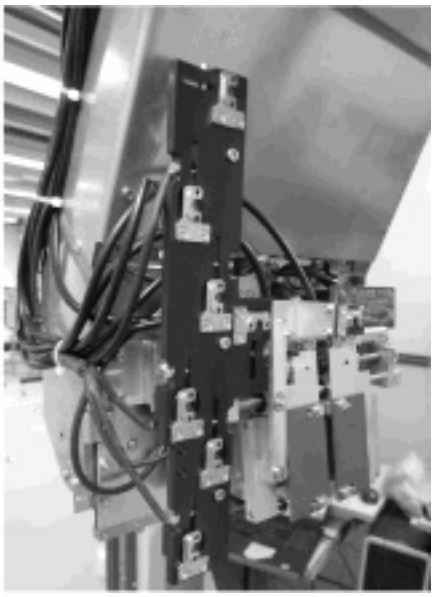
1. Loosen the four screws that hold the **tubehead back cover** in position, two on top and two on the bottom, and remove the cover.



2. Remove the four screws that hold the **tubehead front cover** in position (two on the left and two on the right).

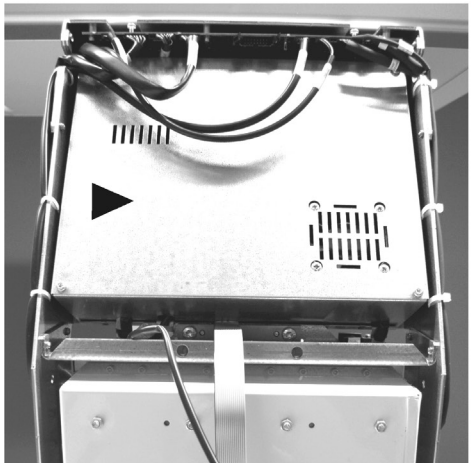


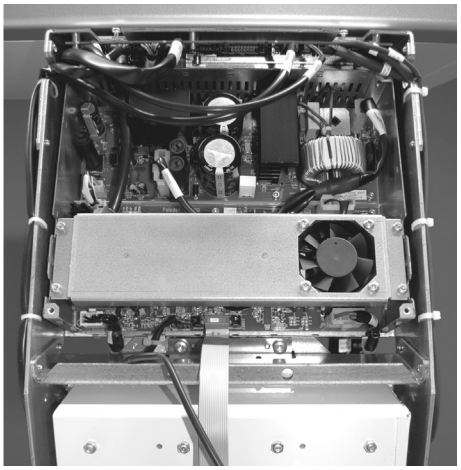
Remove the cover.



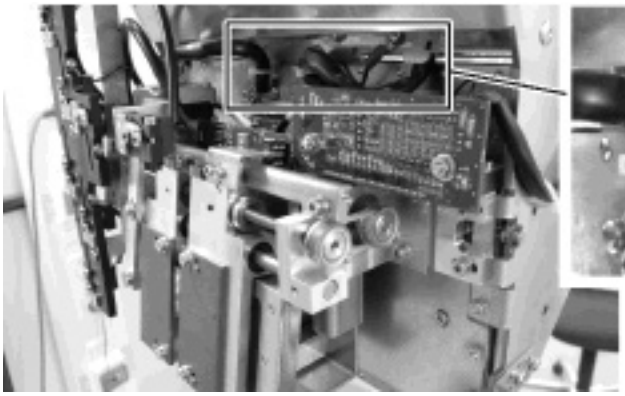
3 . On the rear side of the tubehead assembly disconnect connectors J3314 and J3314 from R3800 X-ray generator

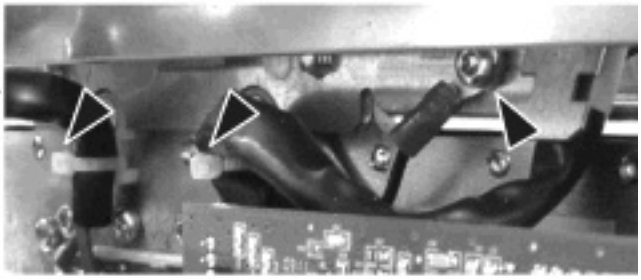
4. Remove the generator cover (4 screws).



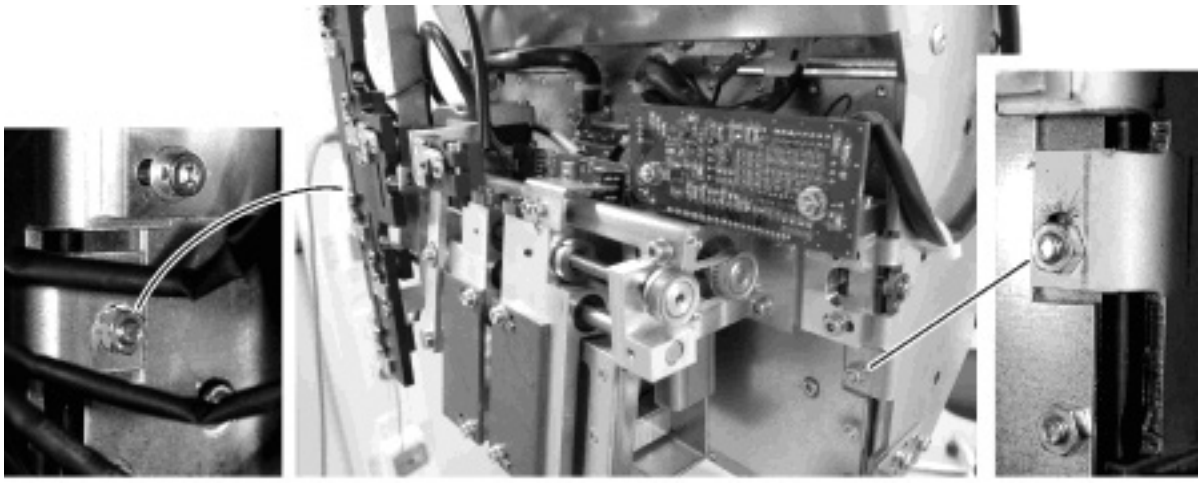


5. On the front side of the tubehead assembly cut the two cable ties that hold the two cables to the rotating unit frame and then disconnect the two cables from R3800 (J3808 and R3809). Also disconnect the ground lead from the rotating unit frame.

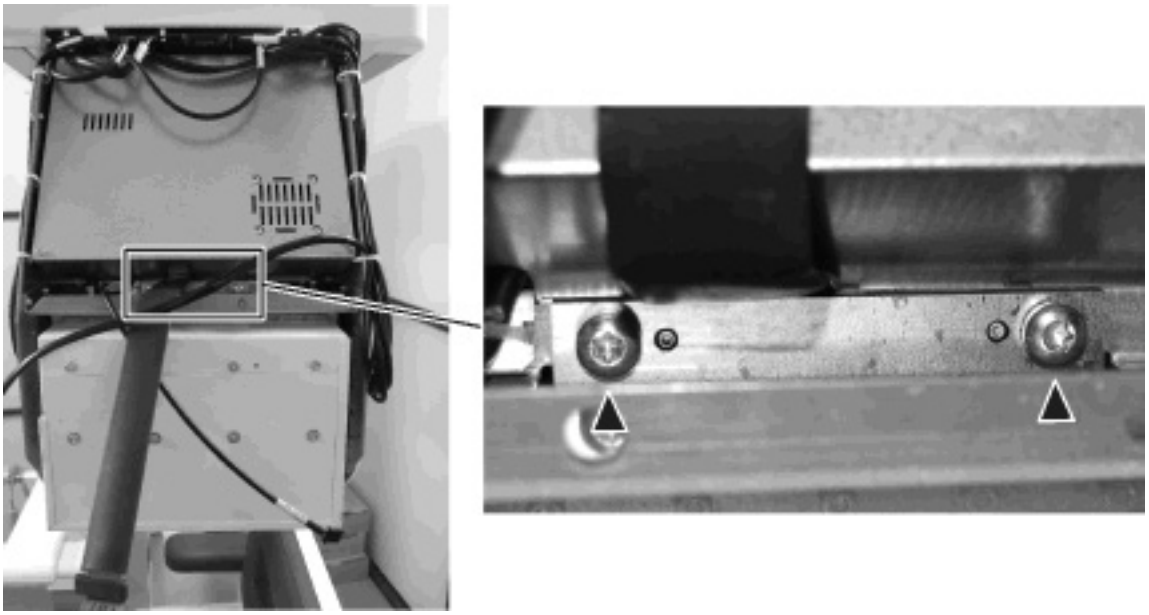




6. On the front side of the tubehead assembly remove the two nuts that attached to the front of the tubehead.

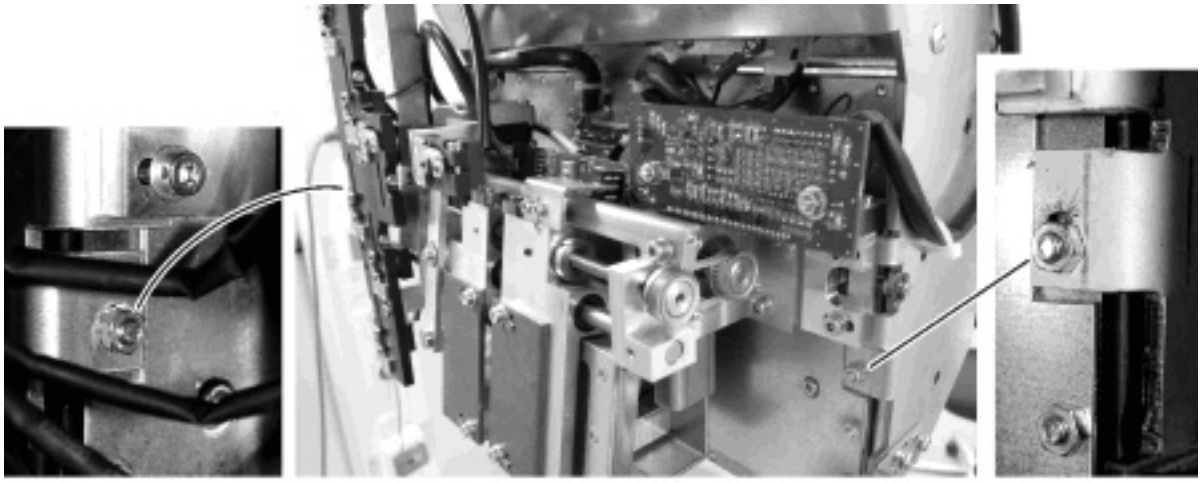


7. Remove the two screw that hold the tubehead to the rotating unit frame. Pins hold the tubehead in position after the screws have been removed. Pull the tubehead backwards and off of the pins.



8. Install the new tubehead. Reconnect all the cables.

   IMPORTANT NOTE:
   When replacing the two nuts on the front side of the tubehead assembly DO NOT tighten then too much. IF they are over tightened the screws in the tubehead housing to which they are attached could loosen and cause the tubehead to leak.



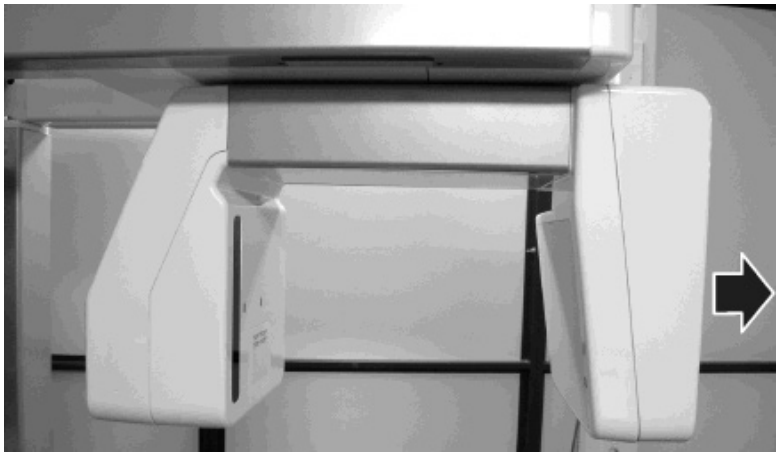
9. Calibrate the unit.

10. Replace all the covers.

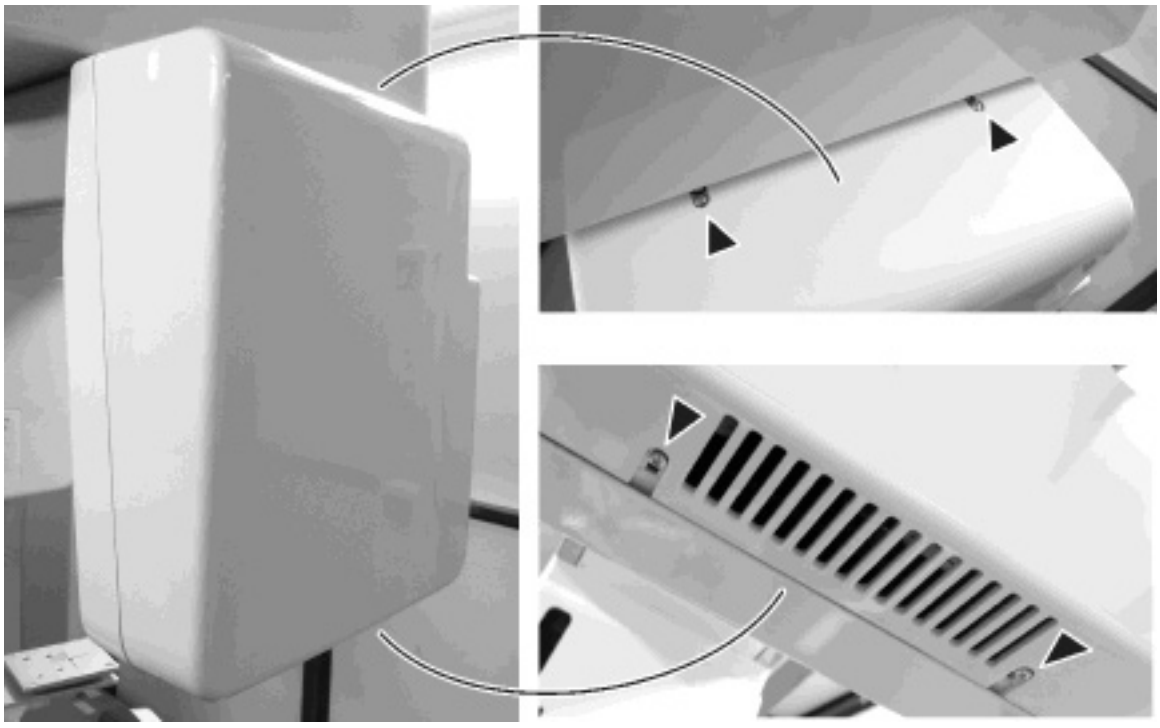
10.2 The 3-D sensor

1. Switch the power to the unit off and disconnect/disable the power supply.

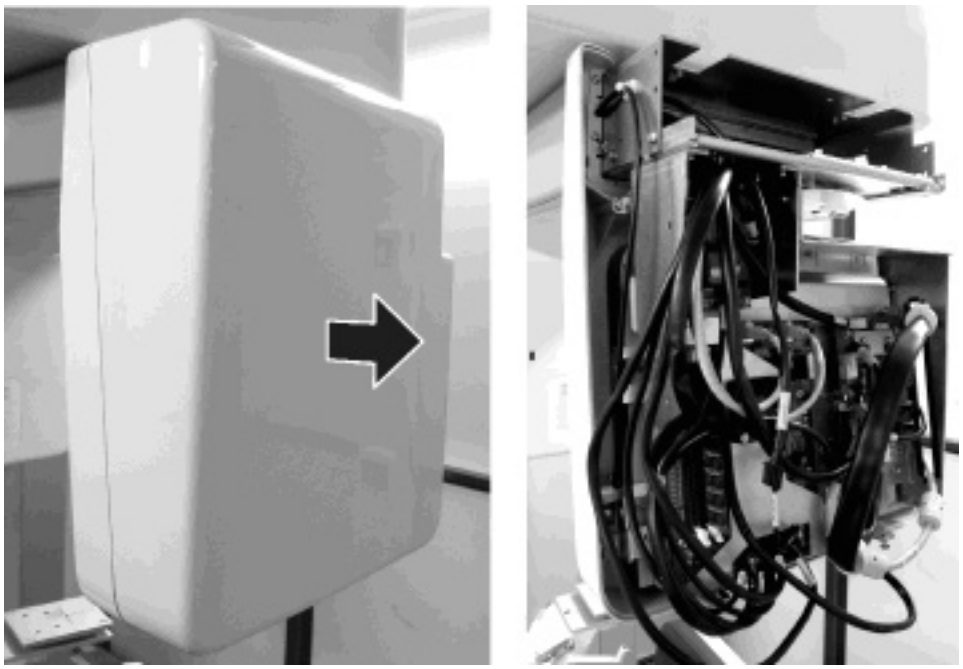
2. Manually pull the rotating unit away from the column so that you can access the sensor head cover screws.



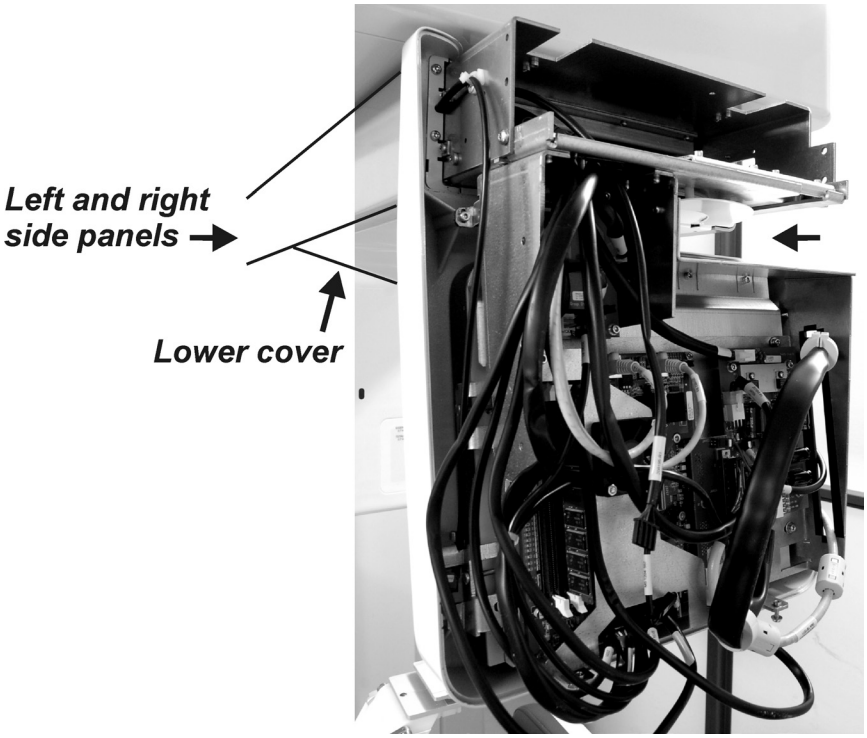
3. Loosen the four (4) screws that hold the back sensor cover in position.



Remove the cover.

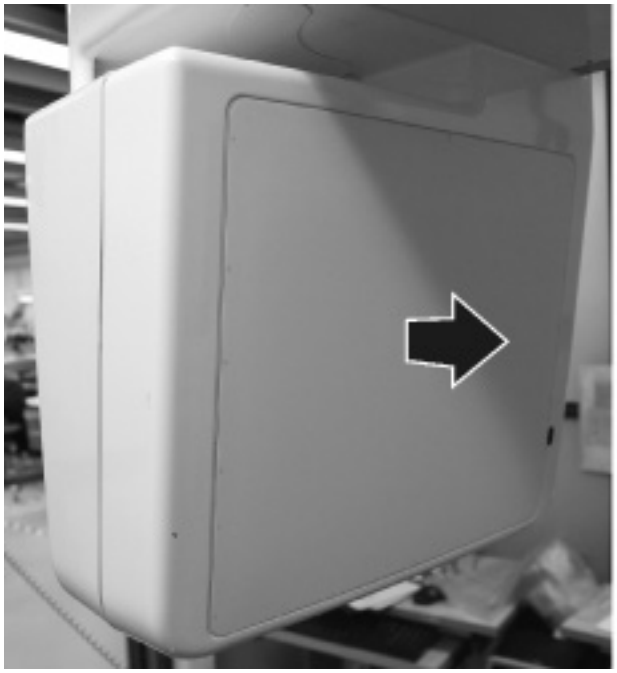


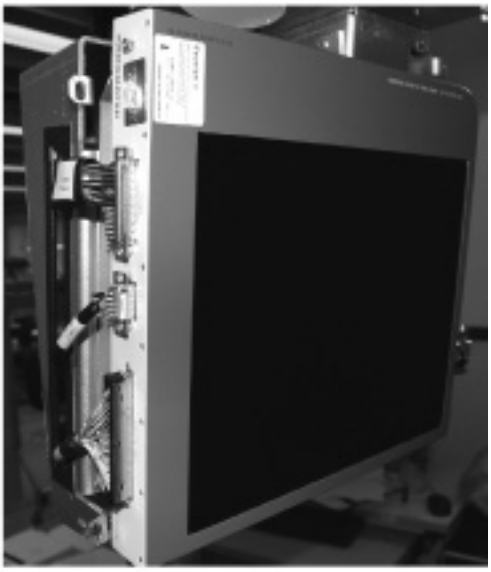
4. Remove the left and right side panels (4 screws per panel) and then the lower cover.



5. Remove the four (4) screws that hold the sensor front cover in position.

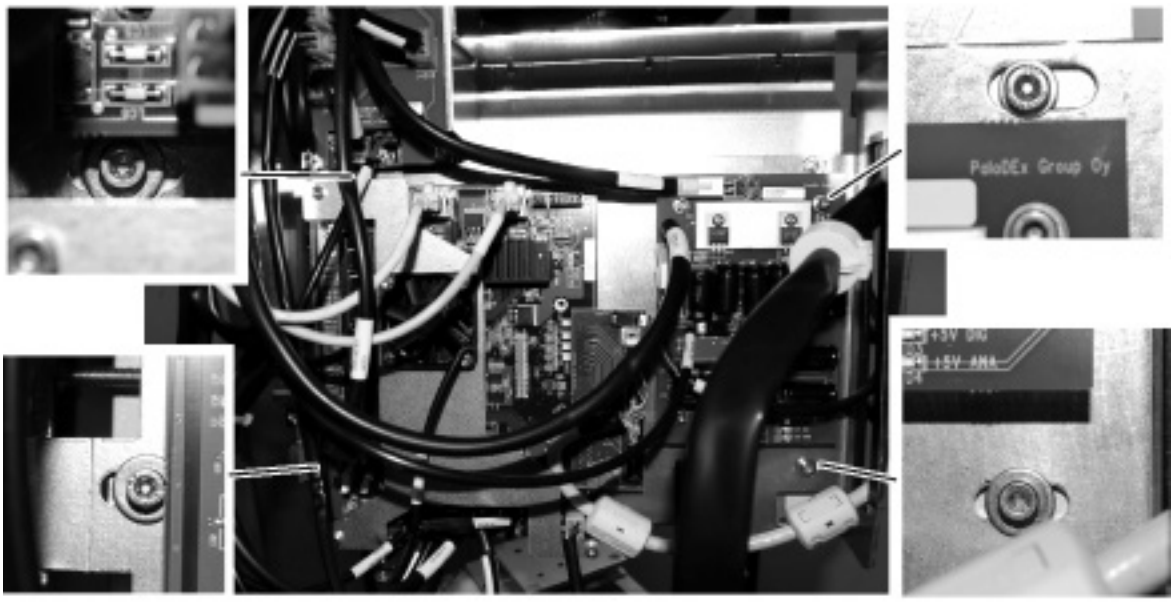
Remove the cover.



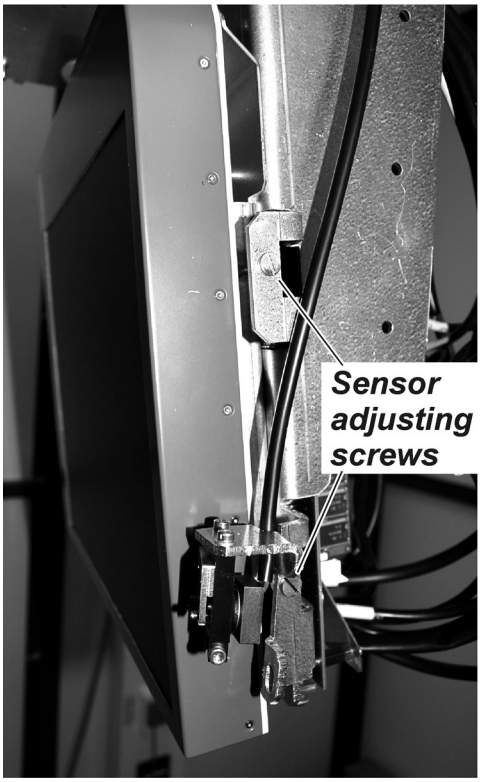


6. Disconnect all the connectors from the sensor.

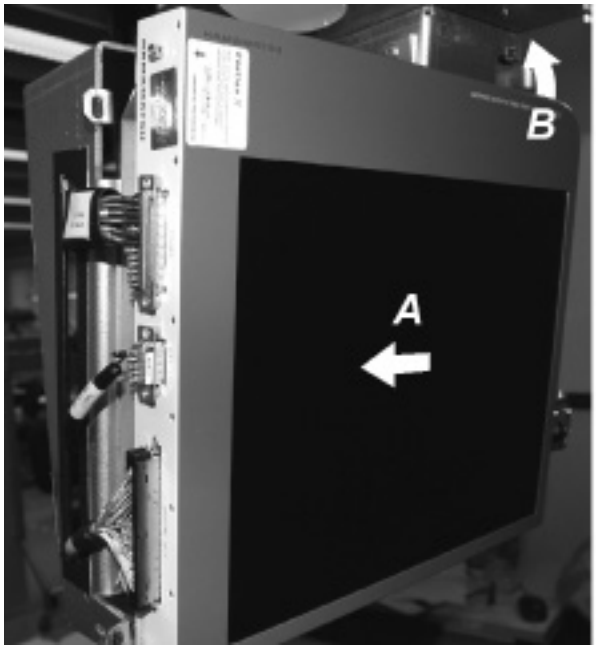
7. Remove the four (4) screws that hold the sensor in position. Note that the sensor will remain in position as a safety screw stops it from accidently dropping.

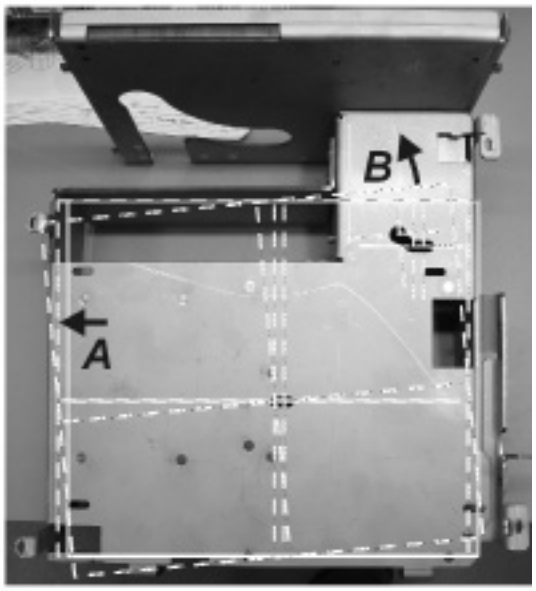


8. Remove the two sensor adjusting screws from the side of the C-arm frame



9. Slide the sensor a few millimetres to the left (A) and then lift the right-hand side up until the sensor and support plate can be removed.





10. Remove the support plate from the old sensor (8 screws) and reattach it to the new sensor.

11. Install the new sensor and then reconnect the sensor connectors.

12. Recalibrate and align the unit. Refer to **9. Unit calibration and adjustment**.

13. Replace all the covers.

10.3 The panoramic CCD sensor

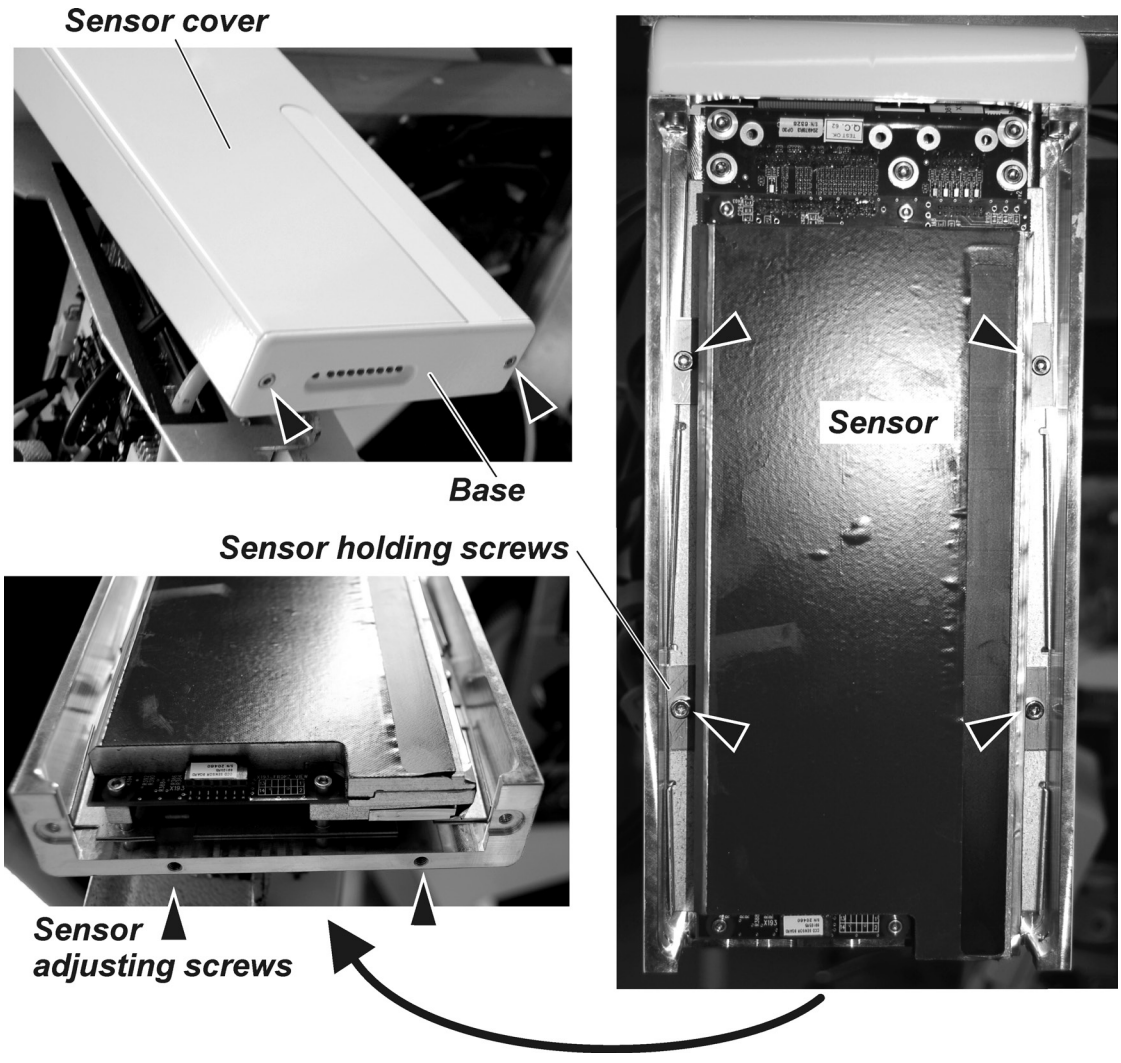
1. While holding the sensor cover remove the two screw from the base of the panoramic sensor and then remove the cover.

2. Disconnect the connectors from the panoramic sensor and then remove the four screws that hold the sensor in position and remove the sensor.

3. Install and reconnect the new sensor.

4. Replace the cover.

5. Recalibrate the unit, see section 8. Unit calibration and adjustment.

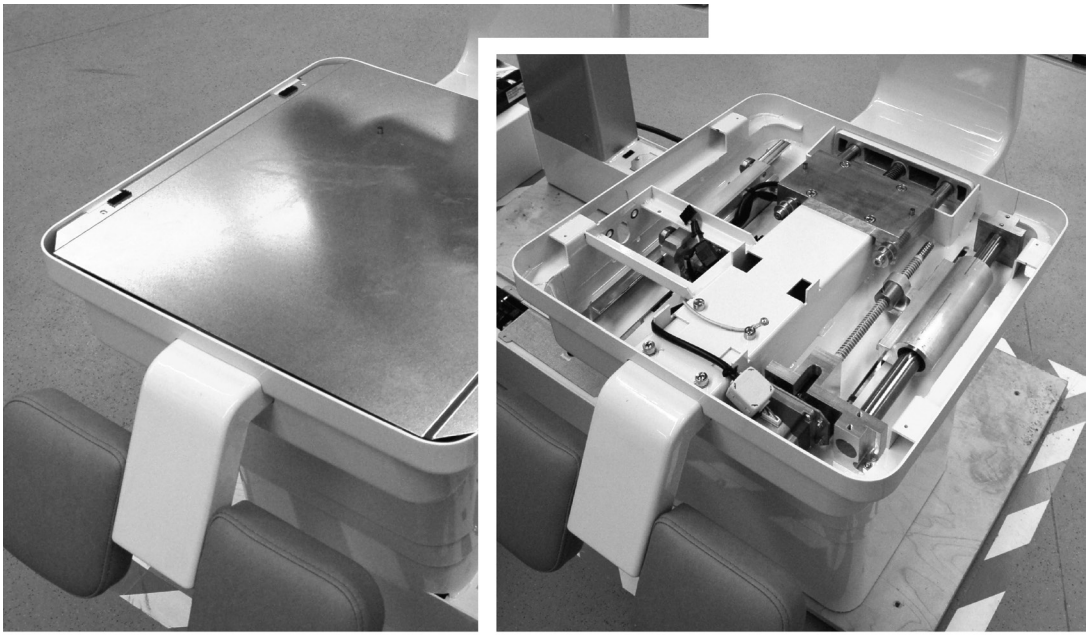


10.4 The chair motor

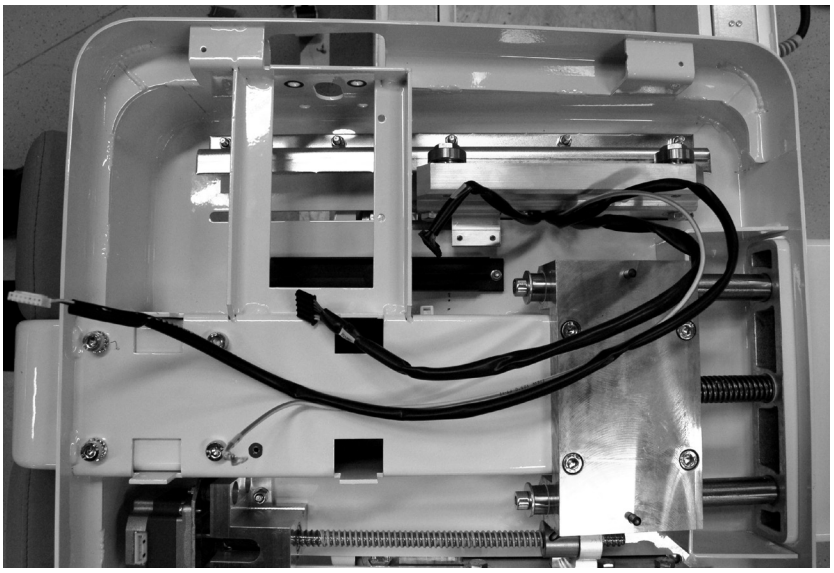
1. If the chair can still be operated, drive it to the lowest position.
   If the chair cannot be operated, it must be manual moved to its lowest position. This can be done after steps 2 - 9 have been completed.

2. Remove the seat and backrest upholstery from the chair. They can be simply pulled off as they are held in position with hook-and-loop fasteners.

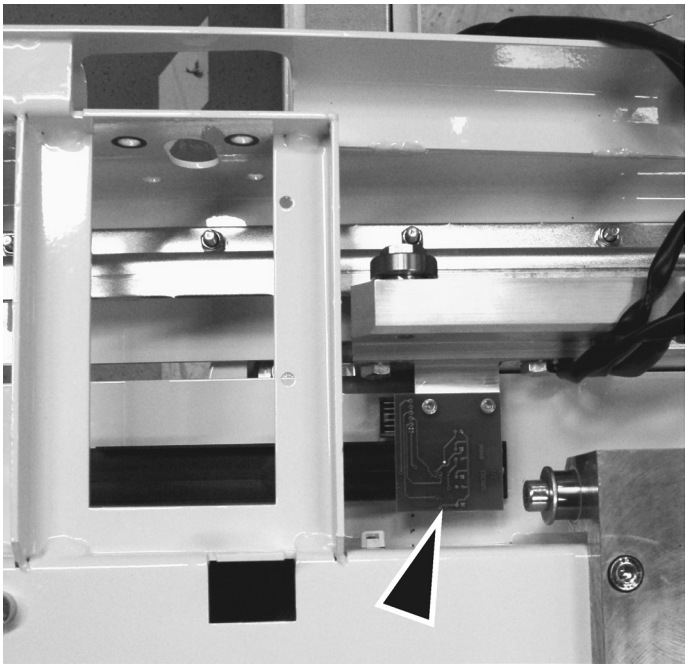
3. Remove the cover plate from the top of the chair (4 screws).



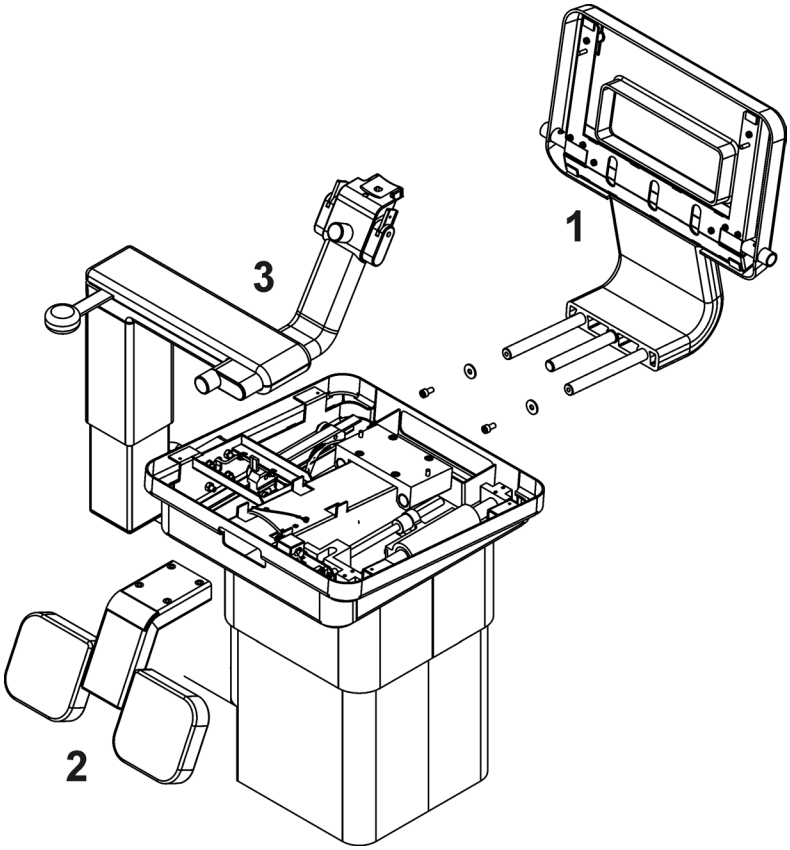
4. Remove all the cable ties that hold the cables to the chair and then disconnect all the cables. Also remove the ferrite rings from the cables that go to the motor.



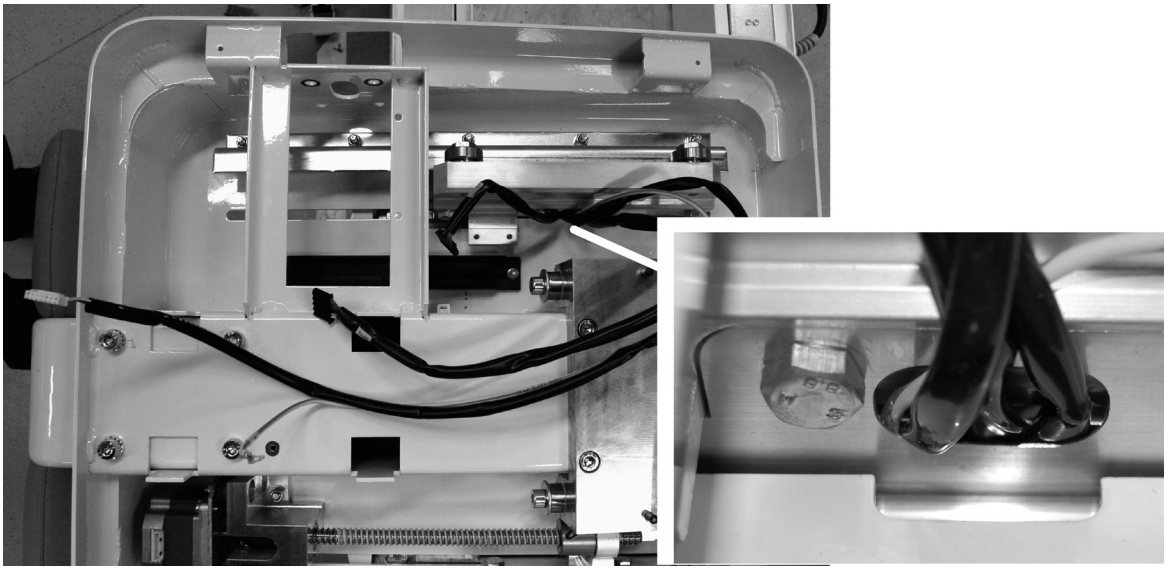
5. Remove N4600 Opto sensor so that you do not damage it when removing the seat base.



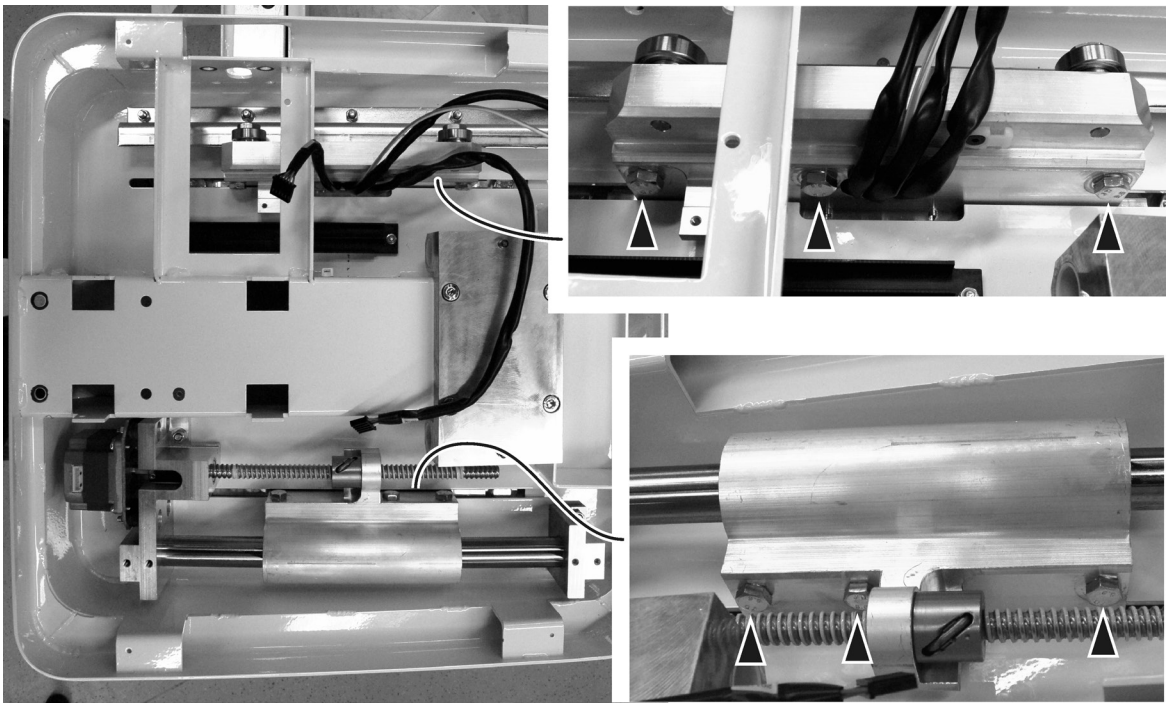
6. Remove the backrest (1), the foot rest (2) and the patient support arm (3).



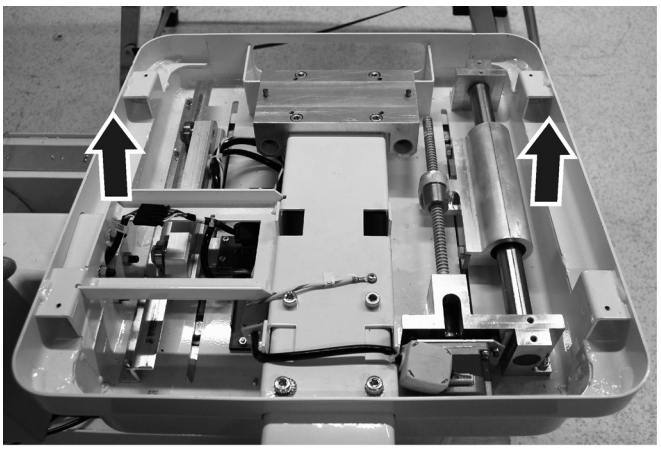
7. Slide the seat backwards so that the cutout in the seat mechanism is next to the hole through which the cables are routed.

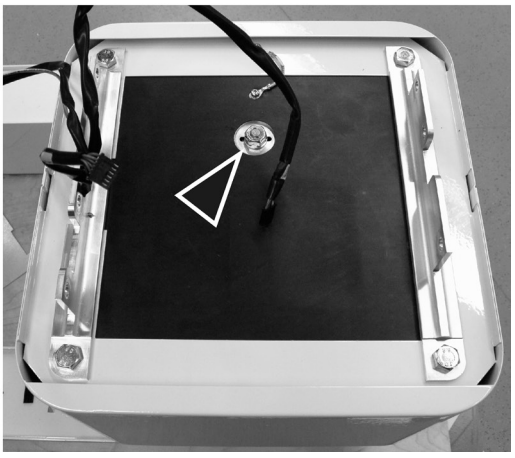


8. Remove the six (6) screws that hold the seat mechanism to the traction and guide brackets (3 for each bracket).



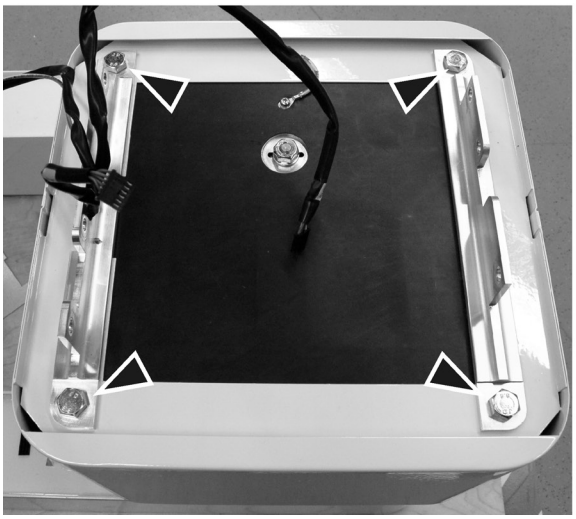
9. Lift the seat mechanism off the chair base.

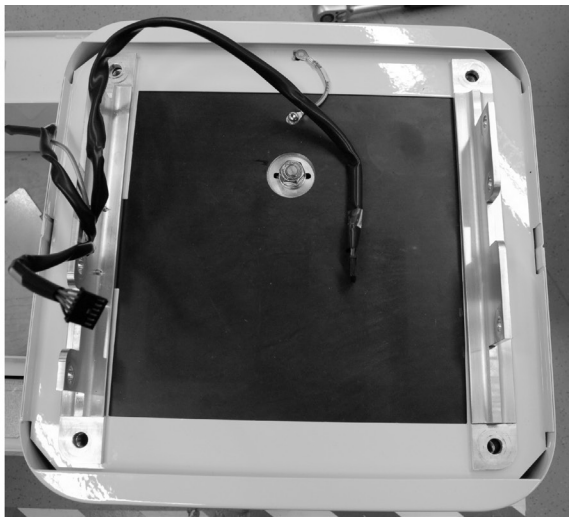




If the chair has not already been driven to its lowest position it can be done now by rotating the motor axle nut.

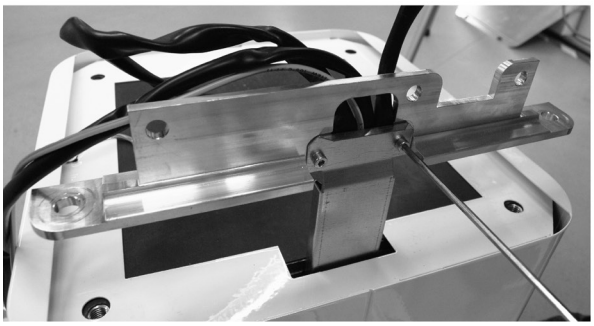
10. Remove to the screws that hold the traction and guide brackets in position (2 screws per bracket).

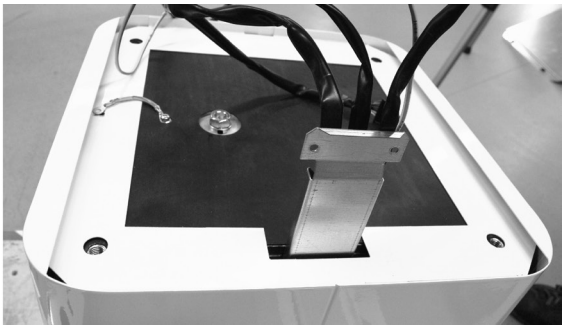


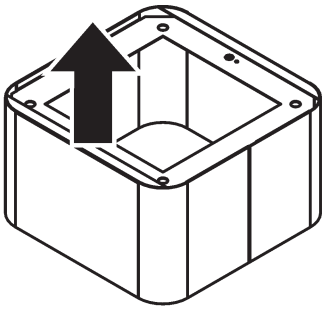


Also remove ground lead from the motor.

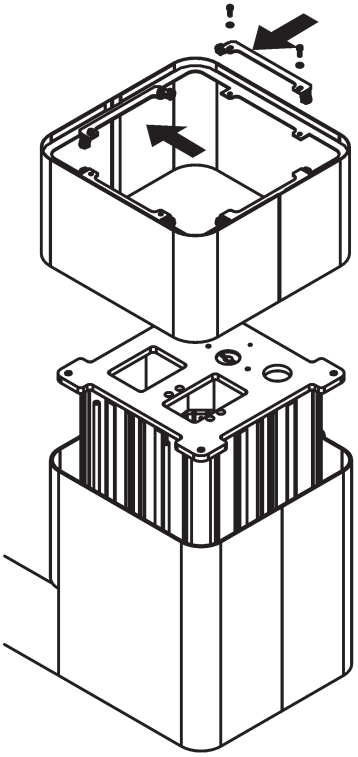
11. Remove the screws (2) that hold the cable harness to the guide bracket.
Remove both the traction bracket and the guide bracket.





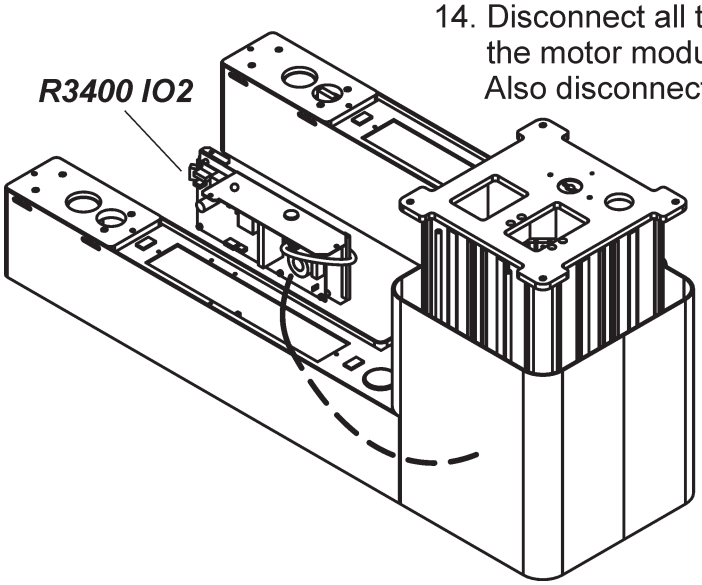


12. Remove the chair lift upper cover.

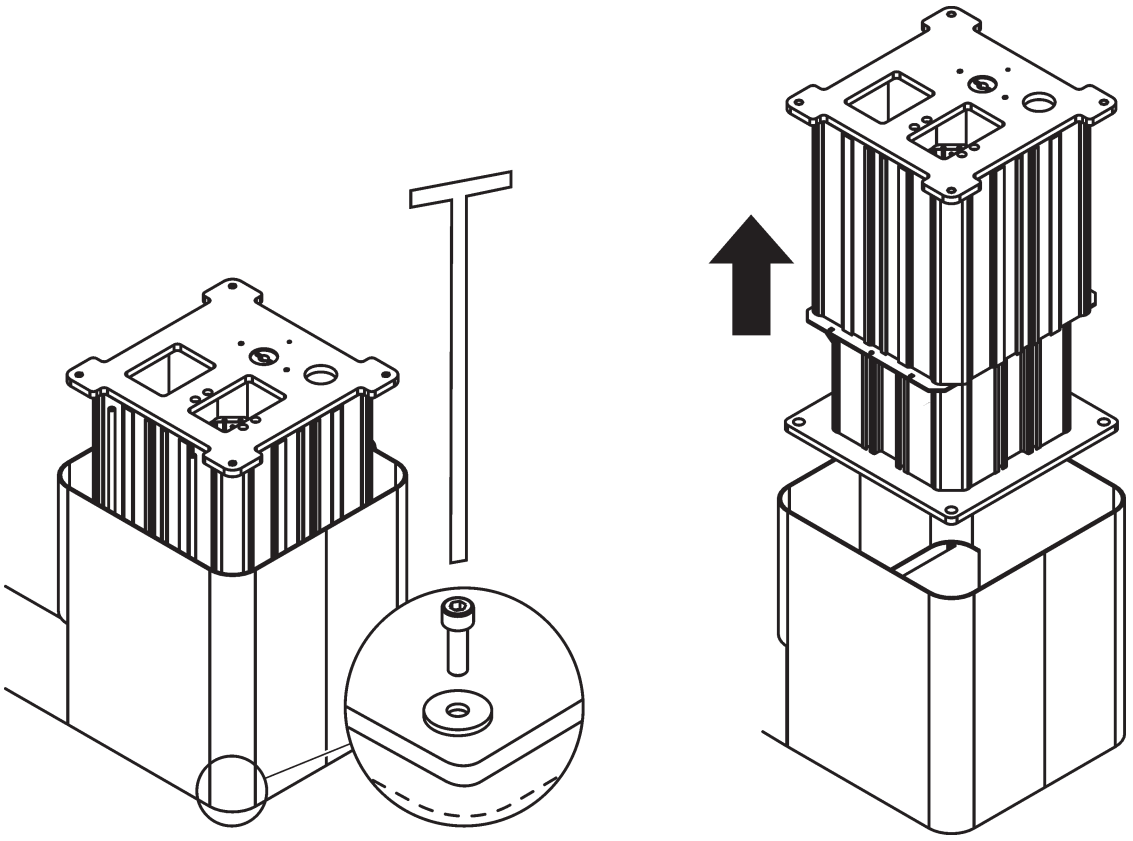


13. Remove the two backlash controllers and then remove chair lift middle cover.

14. Disconnect all the cables that run from the motor module to R3400 IO2. Also disconnect the ground cable from R3400.



15. With an extended M8 hexagon socket wrench remove the screws (4) that hold the motor module to the base.



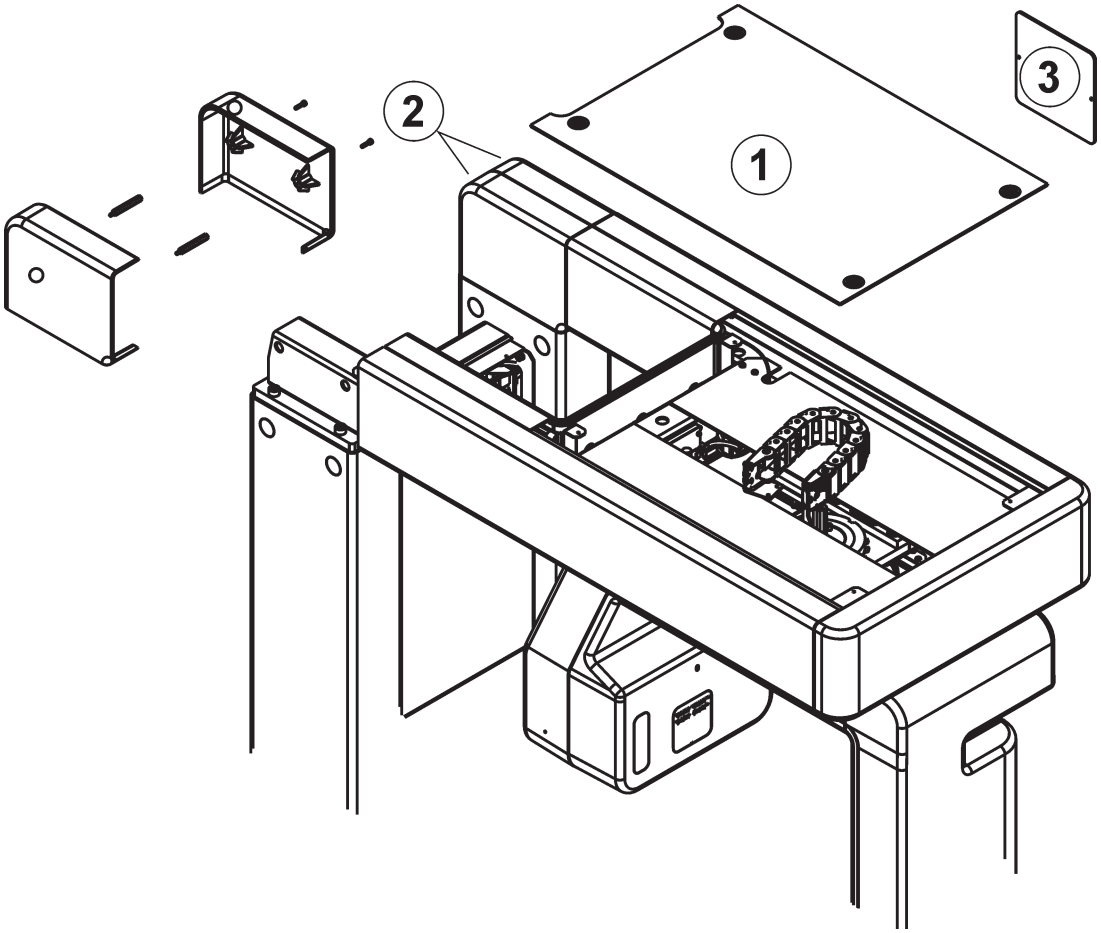
Remove the motor module.

16. Instal the new motor module and then reassemble the chair unit in the reverse order as described above.

17. Recalibrate and align the unit. Refer to **9. Unit calibration and adjustment**.

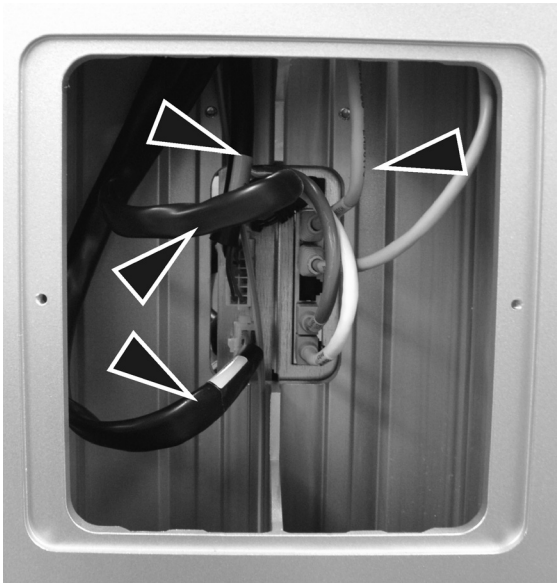
10.5 The cable track

1. Remove the top shelf (1), the inner and outer corner covers (2) from the rear column and column hatch from the rear column.

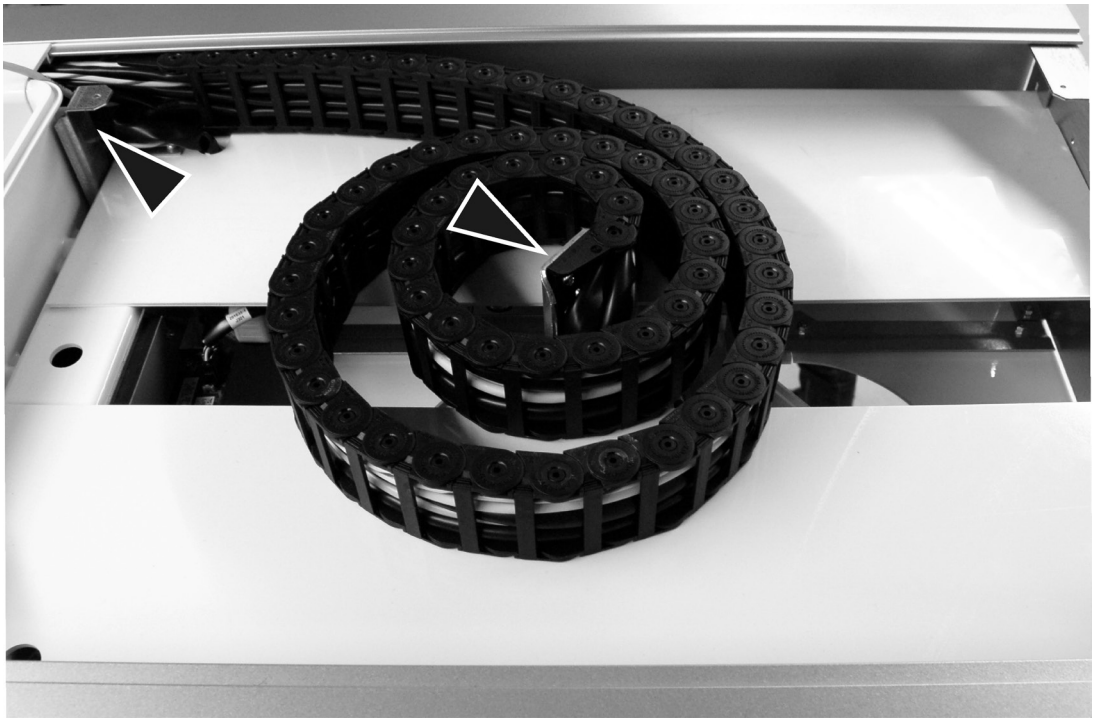


Also remove the inner covers from the rotating unit, see 10.2 The 3-D CMOS sensor

2. From the rear column disconnect all the cables that go to the cable track (accessed through the column hatch.



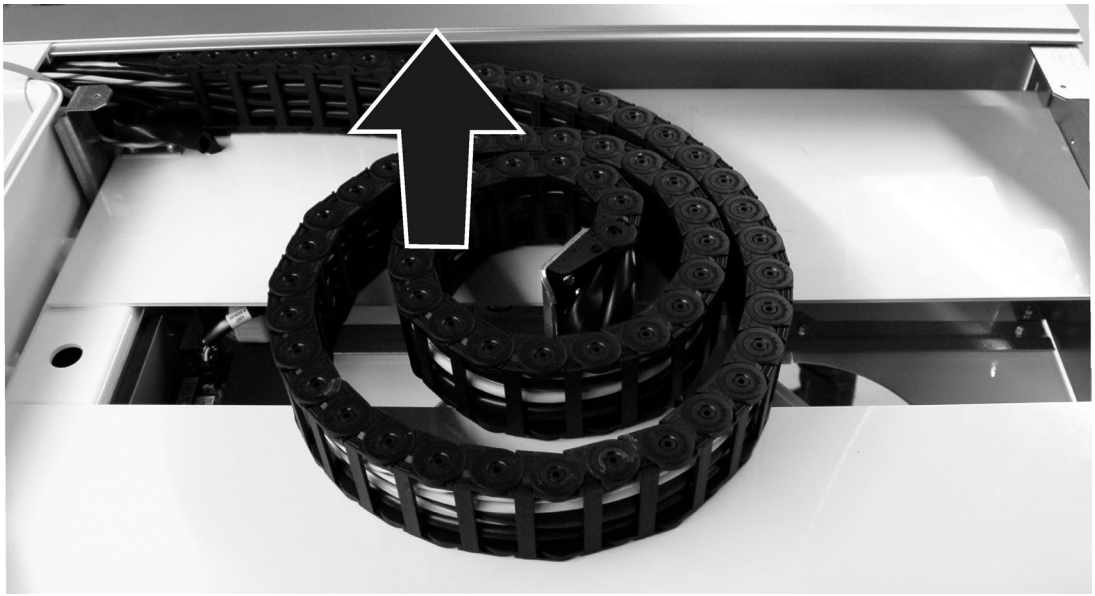
3. Remove the screws that hold one end of the cable track to the upper shelf, and the other end to the rotating unit.



Rotate the rotating unit to wind the cable track into a tight bundle.

4. From the under side of the rotating unit remove all the cable ties that hold the cable track cables in position. Also remove the two cable clamps and the ground lead.
   Disconnect all the cables.

5. Remove the cable track and cable from the upper shelf.



6. Install the new cable track.

10.6 GUI PC

1. Remove the main cover from the electronics cabinet (4 screws, two in top of the electronics cabinet and two on the underside).

2. Unplug all the connectors and ground lead from the GUI PC and then remove it from the electronics cabinet, 5 Torx screws.

3. Install the new GUI PC, reconnect all the cables, the ground lead and then replace the cover. Recalibrate and align the unit. Refer to **9. Unit calibration and adjustment**.